



Winter – 15 EXAMINATION
Model Answer

Subject Code: 17620

Page No: 1/19

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 judgment 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.

Marks

1. a) Attempt any FIVE of the following:	20
a) Discuss about comfort zone and the effect of humidity.	4
<p>Answer : Comfort Zone</p> <p>There is a range of combined temperatures and humidities that provides comfort to most people. This Comfort Zone Chart shows "Indoor Air Temperature" on the vertical axis, "Relative Humidity" on the horizontal axis, and a shaded area known as the "Comfort Zone."</p> <p>Effect of Humidity:</p> <p>Moisture in the air is measured in terms of humidity. Relative Humidity (RH) is the ratio of amount of water vapor in the air to the amount of water vapor in the air at specific temperature and pressure.</p> <p>The control of humidity is not only necessary for human comfort but it is also important from point of view of efficiency of driver. For human comfort, relative humidity is kept within a range of 35% to 60%. A RH more than 60% will lead to sweating, while a RH below 35% will cause dry sensation and affect the mucous membranes, leading to extreme discomfort.</p>	1 1 2

Winter – 15 EXAMINATION
Model Answer

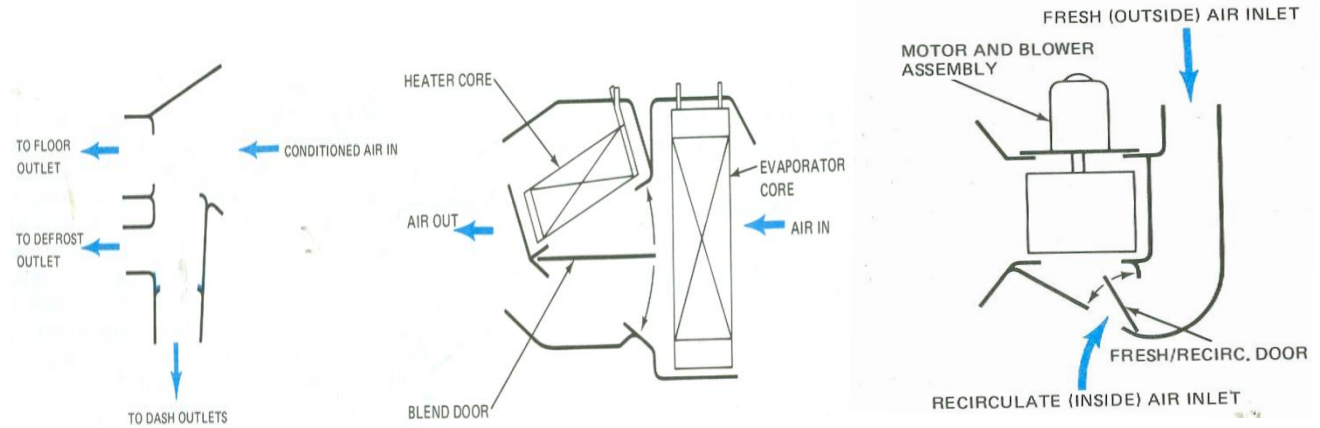
Subject Code: 17620

Page No: 2/19

b) Explain briefly the construction and working of Intake section, Core section and Distribution section

4

Answer:



1

Figure: Air intake , Core & Distribution section

Air Intake Section:

Figure shows schematic sketch of air intake or inlet section. It consists of fresh (outside) air inlet; re-circulate (inside) air inlet, a fresh re-circulate air door, a blower with motor, and an air outlet. The fresh air inlet provides the system with fresh outside air supply; the re-circulate air inlet provides re-circulated in-car air supply. The position of vacuum motor operated fresh/re-circulate door depends on system mode.

1

Core Section:

Following figure shows schematic sketch of core section. It is the central section of duct system. It is also called the plenum section. It consists of heater core, the air conditioning evaporator, and a blend door. Air flow is from right to left in the figure. The blend door usually Bowden cable operated, provides full range control of airflow either through or bypassing the heater core. All air passes through air-conditioning evaporator. In this section full range temperature conditions are provided for in-car comfort.

1

Distribution Section:

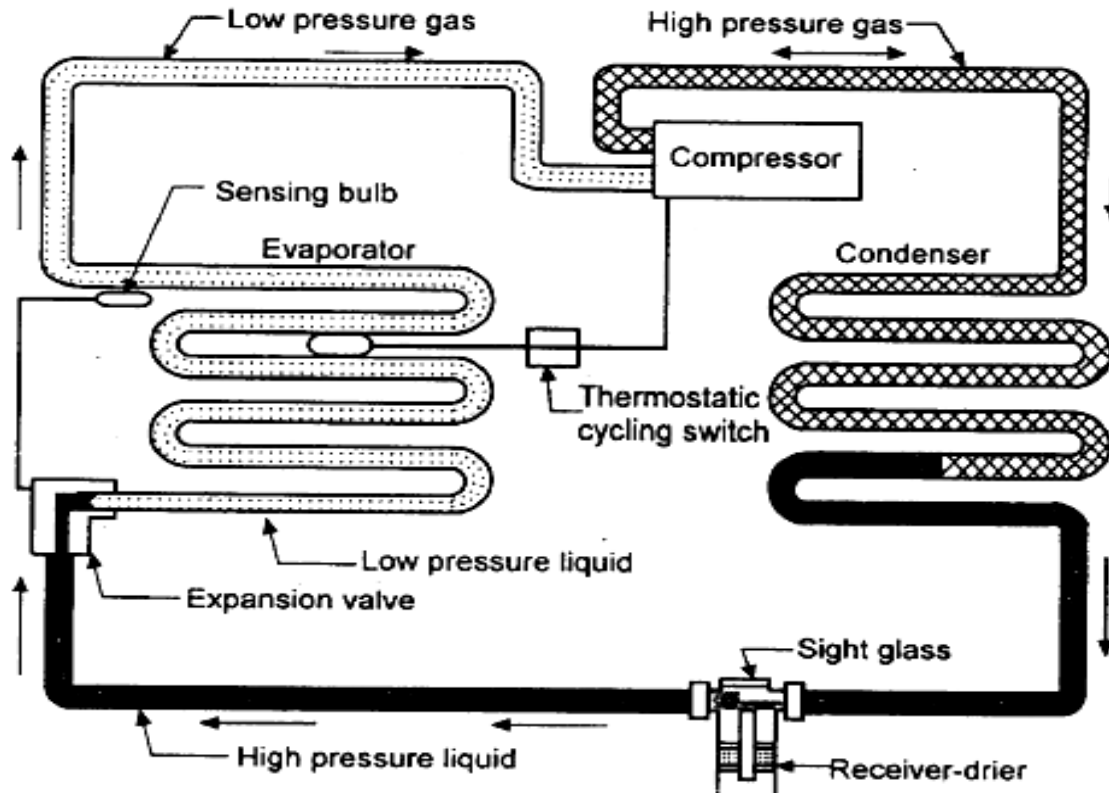
A schematic sketch of distribution section is as shown in the following figure. It directs conditioned air to be discharged to the floor outlets, the defrost outlets, or the dash panel outlets. Also, depending upon the position of the mode doors, conditioned air may be delivered to any combination of outlets.

1

c) Draw general layout of automotive air conditioning system and briefly explain it.

4

Answer: General layout of Automotive AC system:



2

Figure: General layout of automotive A/c System

Following are the basic components in every automobile air conditioning system.

1. **Compressor:** It is used to compress vapour refrigerant coming from the evaporator and supply high pressure vapour refrigerant to condenser.
2. **Condenser:** The function of the condenser is to condense vapour refrigerant into liquid.
3. **Expansion valve:** The function of expansion valve is to meter and control the flow rate of liquid refrigerant and reduce the temperature of liquid refrigerant.
4. **Evaporator:** The function of the evaporator is to give refrigerant effect by exchanging heat to the liquid refrigerant.
5. **Accumulator or receiver drier:** The receiver drier act as storage tank for the liquid refrigerant and also absorbs the moisture from the refrigerant.

2

Winter – 15 EXAMINATION

Subject Code: **17620**

Model Answer

Page No: 4/19

d) Explain the working of electronic temperature control system.

Answer:

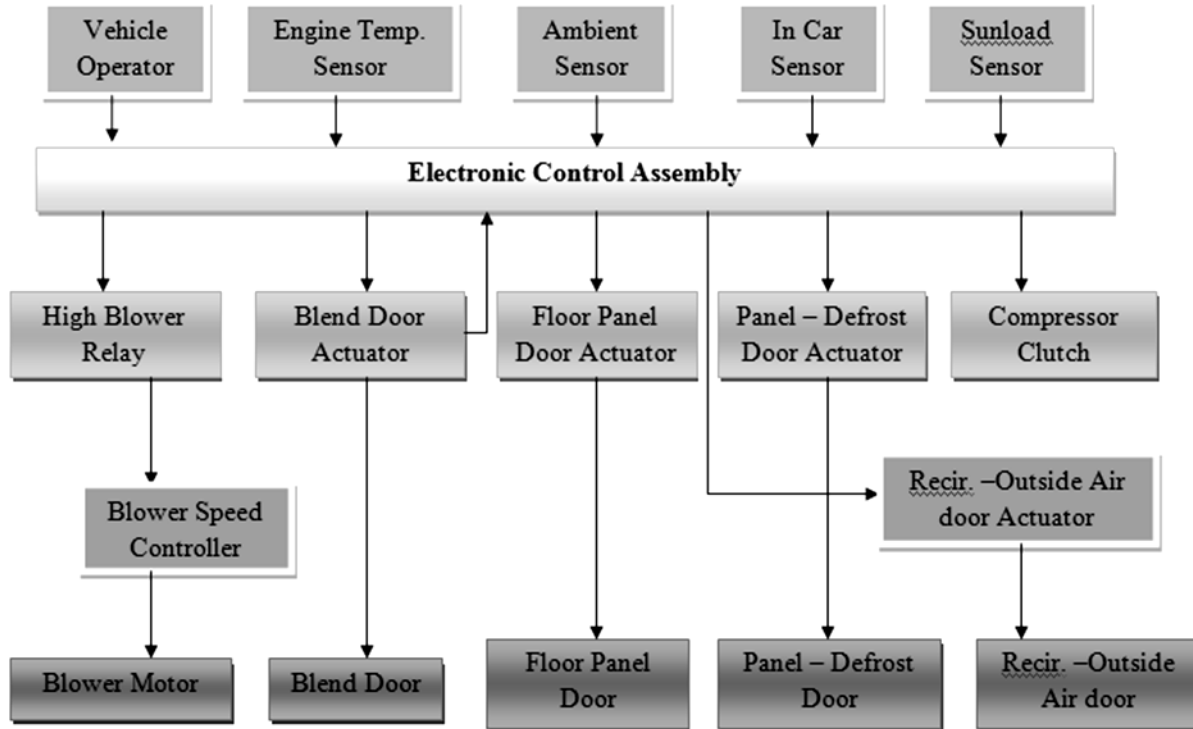


Figure: Electronic Temperature control system

An electronic temperature control system allows us to choose the temperatures we like. We first set our chosen temperature into the air conditioner control. The system will automatically adjust air temperature, mode (panel or floor), and blower speed to maintain the set temperature.

Above figure shows block diagram of electronic automatic temperature control assembly. This assembly receives inputs from five major sources. These are

1. Sun load sensor
2. In car sensor
3. Ambient temperature sensor
4. Engine temperature sensor
5. Vehicle operator

Using these inputs EATC control module determines the correct conditions for six outputs. These are four doors, blower motor and compressor clutch. An electric motor or actuator operates the temperature blend door. Vacuum motor operates the other three doors.



Winter – 15 EXAMINATION

Subject Code: 17620

Model Answer

Page No: 5/19

e) Explain the following from maintenance point view: i) Visual check ii) Accoustic check iii) Leak test iv) Temperature test	4
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Answer:	
1. Visual and acoustic check:	
<p>a) Check V-belt Tension: A slack V-belt slips, reducing compressor speed and limiting refrigerative capacity. To prevent such trouble, the following care is taken. Push down on the centre of the V-belt with finger and check distance it moves. A worn V-belt must be replaced with new one of appropriate size and model.</p> <p>b) Check Condenser Fins: Wash away any dirt or dust with clean water. Use only soft brush, hard one can damage them. Any damaged fins should be repaired.</p> <p>c) Check Air Filter: A clogged air filter reduces air volume and thus refrigerative capacity. A clogged filter must be changed.</p> <p>d) Check Piping Connections: If the piping connections are soiled with oil, it indicates leakage of refrigerant. Inspect by gas leak detector and retighten any loose connections.</p> <p>e) Abnormal noise:</p>	2
2. Leak test:	
<p>Leaks in the refrigeration system are the major cause of most refrigeration failure. Any leak regardless of its size, if on high pressure side of system will result in the loss of quite good amount of refrigerant. This loss of refrigerant will result in failure of refrigeration system.</p> <p>If the leak is on low pressure side of the system, the effects are even greater. When the compressor operates at pressure lower than atmospheric, air will be drawn into the refrigeration system. Air could be removed from the system but after the effect of having moisture in system may result in the permanent damage to the compressor. Thus leak testing is most important step in the installation of refrigeration system.</p>	1
3. Temperature Test:	
Connect manifold gauge set at high and low side valves	
<ol style="list-style-type: none"> 1. Turn on engine and allow temperature to reach 210C or high. 2. Take tachometer and run engine at 1500rpm. 3. Turn on AC for 5min and close all windows and doors. 4. Before that place thermometer at the centre outlet of AC panel. 5. Compare readings as per specifications. 	1

Ambient Temperature (°C)	21 ⁰ C	26 ⁰ C	32 ⁰ C	37.5 ⁰ C	45 ⁰ C
Temperature raised by thermometer (°C)	2-8 ⁰ C	4-10 ⁰ C	10-17 ⁰ C	17-21 ⁰ C	18-21 ⁰ C

Winter – 15 EXAMINATION

Subject Code: **17620**

Model Answer

Page No: 6/19



Winter – 15 EXAMINATION
Model Answer

Subject Code: 17620

Page No: 7/19

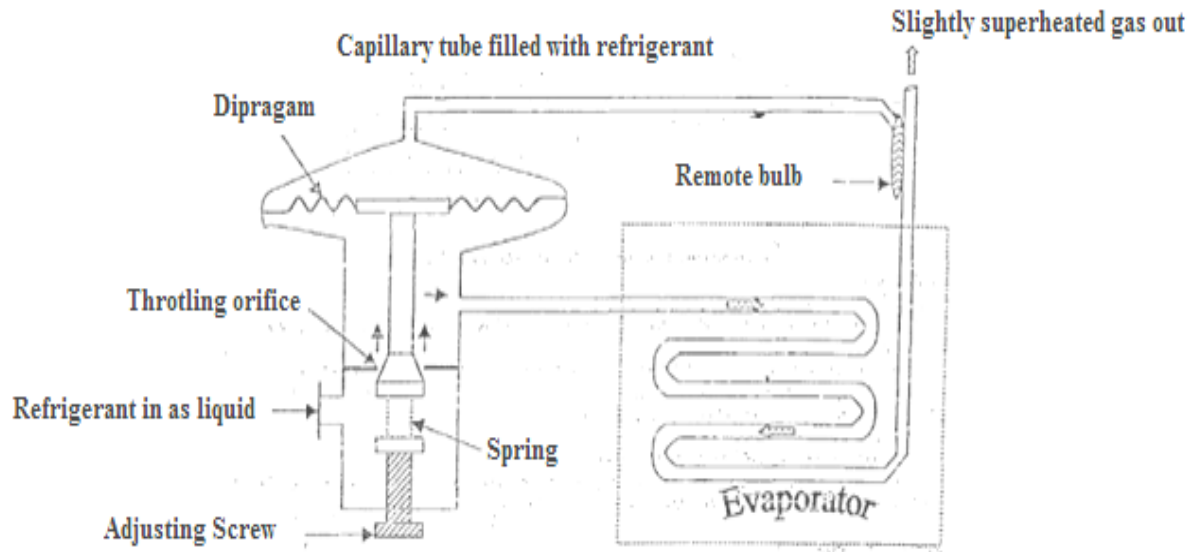


Figure: Internally equalized thermostatic expansion valve

2

2. Attempt any four of the following :

16

a) Explain controlled and uncontrolled ventilation

4

Answer:

There are two methods of ventilation available such as uncontrolled ventilation and controlled ventilation.

1. Uncontrolled ventilation: Uncontrolled ventilation occurs when anyone opens window so that air can enter. This method has been used for years. It has the advantage of providing almost any quantity of fresh air quickly. However, the disadvantage is that opening the window also allows, wind, rain, dust and other airborne particles to enter.

2

2. Controlled ventilation: Controlled ventilation is of two types, namely ram air type and power type.

i. Ram Air Ventilating System: Forward movement of car forces or rams air through the ducts and into the car. The air from outside enters the vehicle through openings in front grill. The entry of this air is controlled by suitable valves or doors. This is done either manually by cables or by vacuum motors. This basic system is used on many vehicles, including those with heaters and air conditioners.

2

ii. Power Ventilating System: In this system, blower motor is provided additionally to ensure sufficient circulation of outside air through the car. The blower motor can be operated at various speeds to suit the ventilating needs of the occupants in car. Normally this system includes heater and an air conditioner system.

Winter – 15 EXAMINATION

Subject Code: **17620**

Model Answer

Page No: 8/19

Winter – 15 EXAMINATION

Subject Code: **17620**

Model Answer

Page No: 9/19



f) Explain refrigerant charging and discharging procedure.	4
<p>Answer : Procedure of charging:</p> <ol style="list-style-type: none">1. Gauge set attached to the service valves.2. Gauge valves closed.3. System should be under vacuum.4. Attach centre gauge hose to refrigerant supply.5. Open valve on refrigerant container.6. Purge air from centre hose by loosening the hose at gauge end.7. With system off, open high pressure gauge valve. Refrigerant can be added as a vapour or liquid at this time.8. As the gauge pressure both reach 60-80psi no further charging will occur.9. Close high pressure gauge valve.10. Place refrigerant supply upright so as to allow vapor to enter system.11. Operate engine at 1500 rpm and turn on the air conditioner at maximum cooling and highest blower speed.12. Open low side gauge valve which will admit refrigerant into the system.13. Charge until proper weight of refrigerant has been added and sight glass clears. Close low pressure gauge valve.14. Charge is complete and vehicle should be returned to idle speed and turned OFF.15. Remove gauge set carefully16. Install protective caps on valves.17. As final check use the leak detector and check for leaks. <p>Procedure of discharging:</p> <p>When leaks or faulty components are found in refrigeration system, the system must be discharged before the repair work is starts. The procedure for discharging is as follows:</p> <ol style="list-style-type: none">1. Attach gauge set in place.2. Place centre hose of gauge set into floor exhaust outlet or near the floor in well-ventilated area.3. Open high pressure gauge valve slowly so that refrigerant should escape through centre hose of gauge set.4. Regulate flow of discharge so that very little oil is observed coming out of the centre hose.5. Open low side gauge valve; regulate so as to control oil discharge also.6. When both gauges register zero and no gauge pressure can be felt within the centre hose by your finger outside the hose, then system can be serviced safely.	2
3. Attempt any FOUR of the following :	16
a) List out at least four common faults that generally occur in automotive A/c.	4
<p>Answer: common faults that generally occur in automotive A/c.(Any Four)</p> <ol style="list-style-type: none">1. Insufficient Cooling2. Noise in compressor3. Compressor not working4. Low Compressor discharge pressure5. High compressor discharge pressure6. Low suction pressure	4



Winter – 15 EXAMINATION
Model Answer

Subject Code: 17620

Page No: 11/19

7. High suction pressure
8. Evaporator Pressure too High
9. Evaporator Pressure too Low

b) Briefly discuss about various modes of heat transfer.

4

Answer :

Conduction:

The conduction is considered as transfer of heat within the substance from high temperature region to low temperature region. Conduction of heat is due to the vibration of molecules. In conduction there must be physical contact or touch.

4

Example of conduction: When solid bar of metal is heated from one end, we find other end of the metal is getting hot

Convectionheat transfer:

When fluid flows over hot solid body, heat will be transferred from hot body to flowing fluid. Thus convection is transfer of heat due to fluid flowing or due to transfer of molecules.

Example of Convection:Heat transfer in water tube boiler where water is heated by hot flue gases.

Radiation heat transfer:

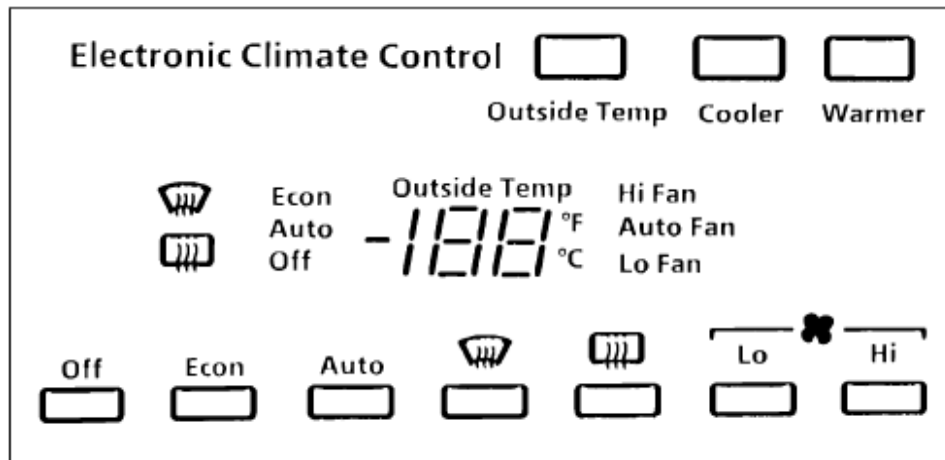
Conduction and convection heat transfer need some medium. In radiation there is no need of any medium for transfer of heat. It can take place in space also, from body at high temperature to body at low temperature in the form of electromagnetic waves emitted by vibrating electrons at surface of body. The quantity of heat radiated depends upon absolute temperature of body.

Example of radiation: Energy emitted by sun reaches the earth through radiation

c) Draw labelled block diagram of electronic climate control system.

4

Answer:- **Electronic Climate control system:**(Note: Credit shall be given to any other suitable sketch)



4

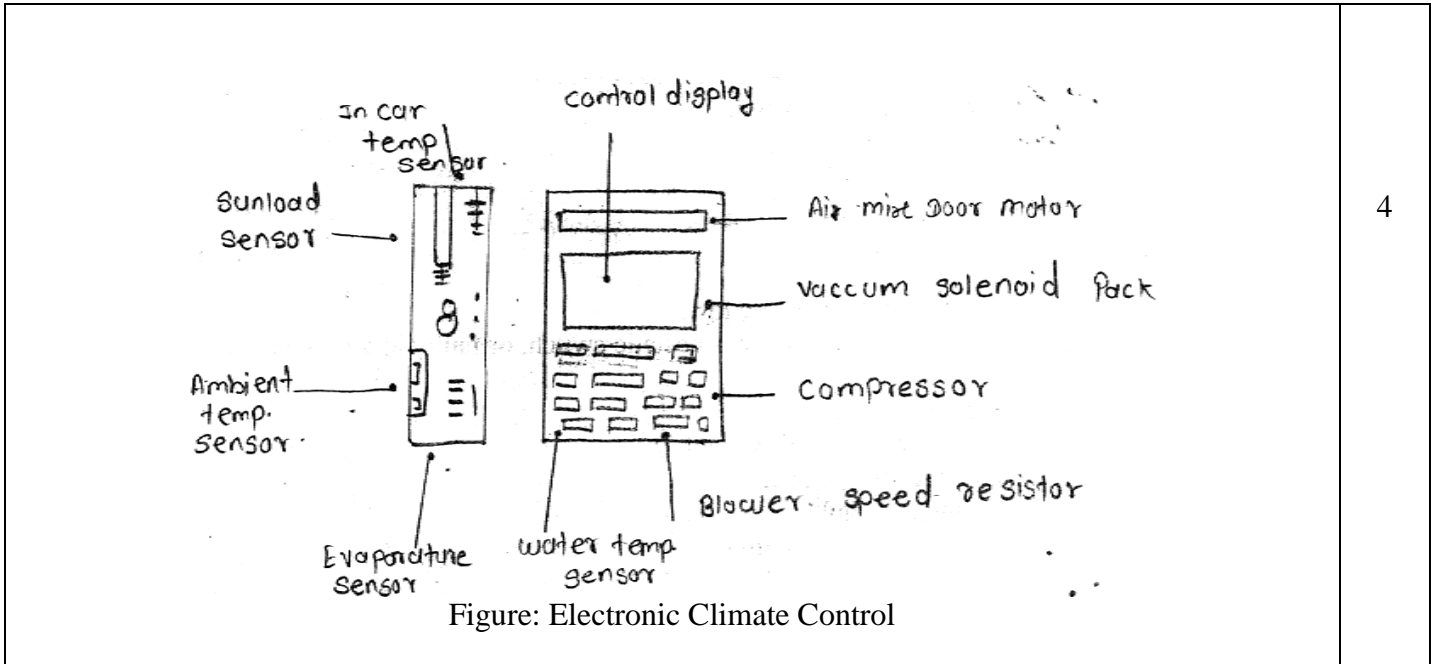
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Winter – 15 EXAMINATION

Subject Code: **17620**

Model Answer

Page No: 12/19



d) For problems mentioned below provide causes and remedies:
i) Less Cooling ii) A/c not starting. 4

Answer:

Sr No	Fault	Causes	Remedies	
1	Less cooling	Low Air Flow	1) Check Blower Operation & Repair it 2) Check Obstructions in Air Distribution System & Remove it 3) Check for clogged Evaporator or Condenser & Clean or repair it	2
		Leakage of Refrigerant	1) Check for leakage & Repair it.	
2	A/c not starting	1) faulty Compressor	Check & repair or replace Compressor	2
		2) Faulty Electromagnetic Clutch	Repair or replace electromagnetic clutch	

e) Discuss about requirements of HVAC in heavy goods vehicles. 4

Answer: **Requirements of HVAC in heavy goods vehicles.**

1. In Heavy goods vehicle, Ac system consume significant amount of engine power by the compressor so power consumption should be as less as possible so that it should not affect fuel efficiency of vehicle that much 4
2. Less power consumption & less load on engine does not affect acceleration of vehicle .during this period HVAC system should maintain proper temperature inside goods compartment
3. In goods compartment there should be equal circulation of air among all compartment
4. Noise & vibration of system should be as less as possible



Winter – 15 EXAMINATION

Subject Code: 17620

Model Answer

Page No: 13/19

f) What is blower clutch control? Explain how it works.	4
Answer: Blower and Clutch Control: The means used to convert low current signals from control panel to high current feed to the blower motor. Blower speeds with this control are infinitely variable. The speed is controlled through a resistor strip on temperature door actuator. The resistor strip then functions same as rheostat to input data to the control panel. The control panel in turn inputs the blower speed signal to the blower control. A power transistor circuit is included in blower control which functions to engage compressor clutch circuit. The metal strip on which transistor is mounted serves as heat sink. This assembly is located in the blower air stream to aid in heat dissipation.	1 3
4. Attempt any FOUR of the following:	16
a) Explain the function of check valves and check relays.	4
Answer: Check valve: It allows a flow in one direction. It is mostly used on inlet manifold of an engine to reserve vacuum in reserve tank. It is opened by normal engine vacuum and connects source to tank whenever the manifold vacuum drop below the reserve pressure. It closes and blocks vacuum in reserve tank. Check Relay: It prevents vacuum loss during low manifold vacuum conditions and maintain the sufficient vacuum in the system mode operations during these periods	2 2
b) Discuss any four aspects of HVAC related to environmental effect and safety.	4
Answer: Environmental aspects- 1. To avoid ozone depletion we can replace CFC-12 by HFC-134a. 2. In HVAC system less CO ₂ released. Safety aspects- 1. Always wear eye protection when servicing air conditioning system or handling refrigerants. 2. Avoid breathing refrigerant and lubricant vapour or missed. 3. Do not allow refrigerant to come in contact with open flames and high temp surfaces. 4. Service equipment's should not be pressure tested or leak tested with compressed air.	2 2
c) Explain in detail the functions of following : i) Vacuum reserve tank ii) Vacuum motor	4
Answer: i) Vacuum reserve tank: Function of vacuum reserve tank is to maintain maximum vacuum values to properly operate air conditioning and heater vacuum controls devices.	2



ii) Vacuum motor: It is a vacuum operated device operates heater and coolant valves and doors. Depending upon pressure difference across diaphragm, it operates plunger so that valves and doors are operated.	2
d) Explain the working of fluorescent leak detector.	4
Answer: Working of fluorescent leak detector: The user adds a small amount of fluorescent dye into the air conditioning system, and then allows the dye to circulate throughout the system. Wherever the refrigerant escapes, so does the dye. Although the refrigerant evaporates, the dye remains at the sites of all leaks. When the system is scanned with a high-intensity ultraviolet or UV/blue light lamp, the dye glows bright yellow to pinpoint the precise location of every leak. This method cuts refrigerant expenses because we find leaks while they are very small. And since we find the leaks so quickly, our labor costs have been reduced considerably.” This method reduces inspection time by 75 percent or more. This leak detection method is so accurate that it locates the smallest, most elusive leaks in tubing, soldered joints, fittings, coils, valves, compressors, and more.	4
e) Why is compressor called as “heart” of vapour compression refrigeration system ? Explain	4
Answer: Compressor is heart of the refrigeration system as it circulates the refrigerant in the system like the heart of a human being circulating the blood in the body. Two different pressures exist in the refrigeration cycle. The evaporator or low pressure, and the condenser, or high pressure. These pressure areas are divided by the other two components. On one end, is the metering device which controls the refrigerant flow, and on the other end, is the compressor. It compresses the low pressure refrigerant vapor from the evaporator and compresses it into a high pressure vapor. The inlet to the compressor is called the “Suction Line”. It brings the low pressure vapor into the compressor. After the compressor compresses the refrigerant into a high pressure Vapor, and the outlet of the compressor is called the “Discharge Line”.	4
f) Explain construction location and working of low pressure switch.	4
Answer: Low pressure switch:	
Location: It is located in the low side of air conditioning system, usually on accumulator.	1
Working: This switch is normally closed and opens when low side pressure drops below 13.8-55.2 kPa. It provides data to processor to disengage compressor clutch circuit to prevent compressor operation during low pressure conditions. Low pressure condition may result due to loss of refrigerant or clogged orifice tube.	3
5. Attempt any two of the following:	16
a) Explain in details the construction and working of rear heating and cooling.	8
Answer: Rear heating system: Some trucks and vans are equipped with rear air distribution system to provide rear heating. A schematic sketch of rear heating system is as shown in figure. Depending on design it may have major components; blower and motor, temperature door, evaporator core with metering device, heater	2

core with flow control, outlet mode door, control panel, and controller. In this system second heater core is located at the rear of passenger compartment. Driver controls overall operation. Some systems allow the rear passenger to control the temperature. For control of rear blower switch is provided at the front or at rear or sometimes at both places.

In this system rear blower forces the air into the second heater core from where heated air enters into the distribution section and finally delivered to the rear compartment.

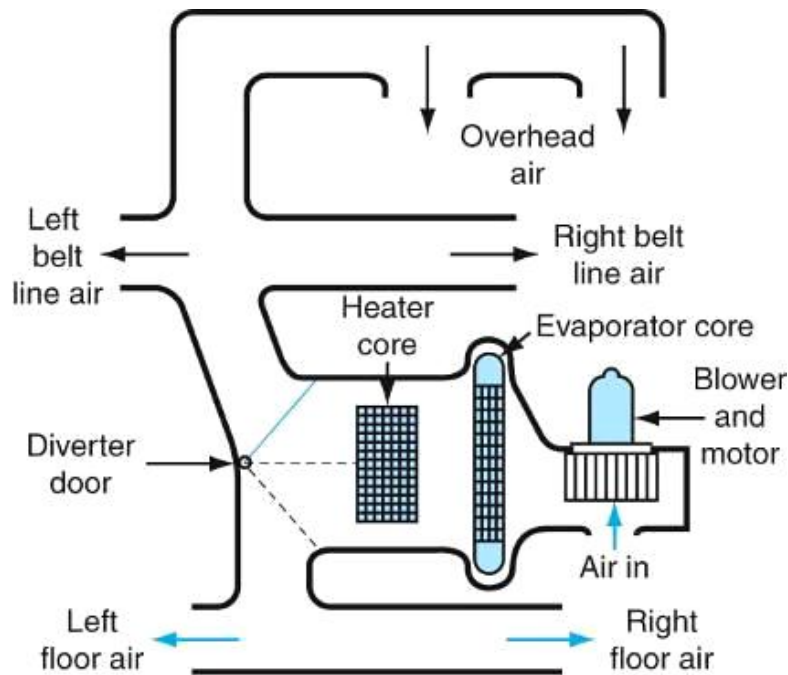


Figure: Rear heating & cooling system

2. Rear Cooling system: Some trucks and vans are equipped with rear air distribution system to provide rear cooling. A schematic sketch of rear cooling system is as shown in following figure. Depending on design it may have following major components; blower and motor, temperature door, evaporator core with metering device, heater core with flow control, outlet mode door, control panel, and controller.

In this system second evaporator core is located at the rear of passenger compartment. Driver controls overall operation. Some systems allow the rear passenger to control the temperature.

For control of rear blower switch is provided at the front or at rear or sometimes at both places. In this system rear blower forces the air into the second evaporator core from where cooled air enters into the distribution section and finally delivered to the rear compartment.

4

2

Winter – 15 EXAMINATION

Subject Code: 17620

Model Answer

Page No: 16/19

b) Draw neat sketch of Thermostatic Expansion Valve (TEV) and explain its working

8

Answer:

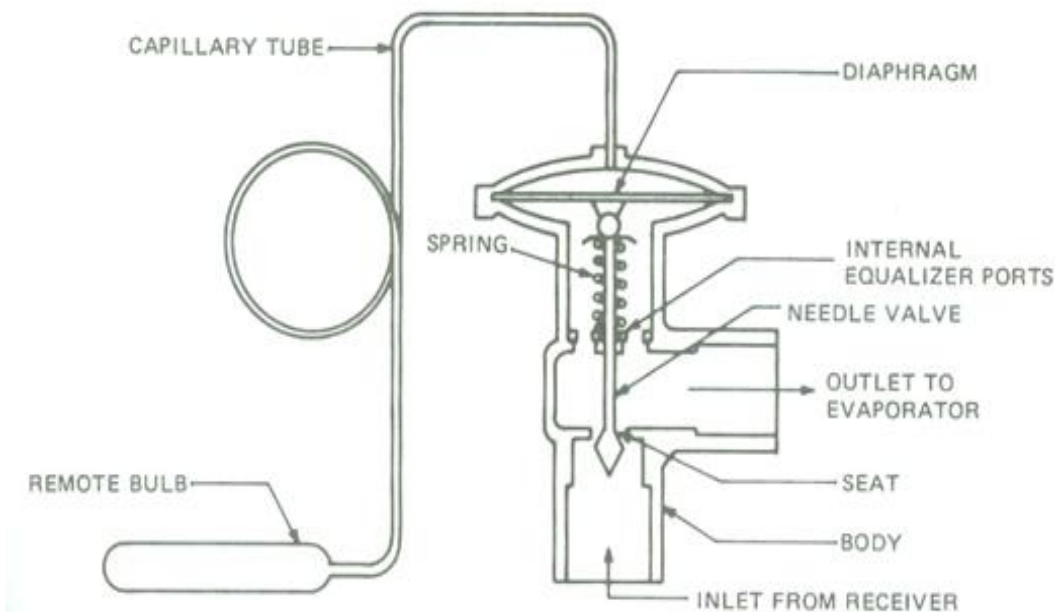


Figure: Thermostatic expansion valve

4

Working: The capillary tube, tube end (bulb, coil or plain end) and upper diaphragm chamber form a closed system filled with a temperature-sensitive gas (refrigerant, carbon dioxide or a similar substance).

The capillary tube, remote bulb is clamped onto the evaporator outlet pipe. It's insulated from the outside air with special tape, so it measures only the temperature of the refrigerant as it leaves the evaporator.

Any increase in refrigerant temperature at the evaporator outlet increases the pressure in the remote bulb and tube system. This in turn exerts a downward pressure on the diaphragm. This downward pressure on diaphragm is greater than combination of the evaporator pressure and the superheat spring pressure. As a result, the valve will open. Similarly, a decrease in refrigerant temperature decreases the pressure in the remote bulb and tube system. This decreases the pressure on the diaphragm and this pressure is less than combination of the evaporator pressure and the superheat spring pressure and allowing the valve to close.

4

c) Explain the construction and working of remote bulb with neat sketch.

8

Answer: Construction and working of remote bulb:

Construction:

Figure shows remote bulb. One end of capillary tube is connected to remote bulb and other end is connected to thermostatic expansion valve. A remote bulb filled with refrigerant same like refrigerant in A/C system. It is located at evaporator outlet. It maintains pressure on diaphragm against evaporator pressure and spring pressure.

3



<p>Working: Piston type compressors go through an intake stroke and a compression stroke for each cylinder. On the intake stroke, the refrigerant from the low side (evaporator side) of the system is drawn into the compressor. The intake of refrigerant occurs through reed valves. These one-way valves control the flow of refrigerant vapors into the cylinder.</p> <p>During the compression stroke, the gaseous refrigerant is compressed. This increases both the pressure and the temperature of the heat-carrying refrigerant. The outlet (discharge) side reed valves then open to allow the refrigerant to move into the condenser. The outlet reed valves may be considered the beginning of the high side of the system.</p>	2
<p>b) What is refrigerant? Enumerate desirable properties of a good refrigerant. Give classification of refrigerant.</p>	8
<p>Answer: Refrigerant is chemical used in a cooling mechanism, such as an air conditioner or refrigerator, as the heat carrier which changes from gas to liquid and the back to gas in the refrigeration cycle.</p> <p>Properties: <i>(Any four)</i></p> <ol style="list-style-type: none">1. It should have low boiling point.2. It should be above atmospheric pressure.3. It should have high latent heat of vaporization4. Toxicity should be low.5. It should be corrosive.6. It should not be inflammable.7. It should be stable in nature.8. It should have low viscosity.9. It should have high thermal conductivity.10. It should be easy and safe to handle.11. It should be easily available at low cost. <p>Classification of refrigerant:</p> <ol style="list-style-type: none">1. Halocarbons or ferons:2. Azeotropic refrigerant3. Zeotropic refrigerant4. Inorganic refrigerant5. Hydrocarbon refrigerant	2
<p>c) Draw the neat sketch of high pressure switch and explain its working. Further state its location. List out the causes which will lead to activation of H.P. switch.</p>	8
<p>Answer: High pressure control switch consists of following main parts- Knob (for adjusting cut out and differential), lock plate, tension spring, compression spring, diaphragm, lever, main body, return spring, retaining spring, electrical contacts, scale, inlet connection.</p>	4



The high pressure cut-out used in refrigeration unit is connected to the high pressure side of the compressor or to line between the compressor and the condenser. The high pressure switch is normally closes and opens if air conditioning system pressure exceeds predetermined pressure values. The high pressure control operates and stops the compressor by cutting off the power supply to the compressor motor. When the pressure returns to normal, the control acts to close the power supply and starts the compressor. this high pressure control is necessarily required on the refrigeration system which uses water cool condenser because there is every possibility of sudden water supply failure which may increases the discharge pressure abruptly. This switch provides safety, if pressure exceeds safe limits for any reason.

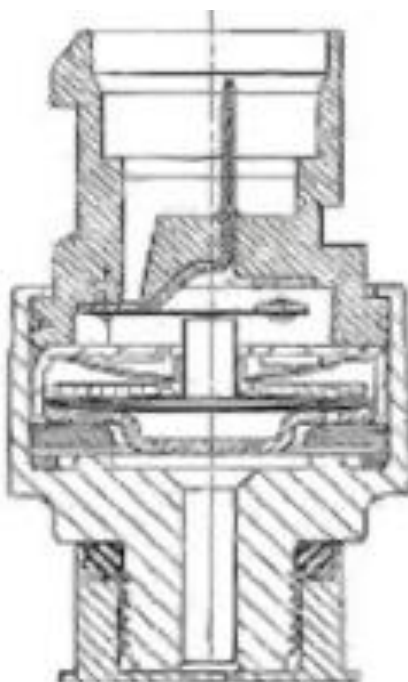


Figure: High pressure switch

Location: This switch is usually in line with the compressor clutch circuit.

Causes which will lead to activation of H.P. switch:

1. If air conditioning system pressure exceeds predetermined pressure values.
2. Overcharge of the refrigerant or air in the system.
3. Restrictions in condenser or receiver and dryer.
4. Evaporator pressure is too high.

1

1

2