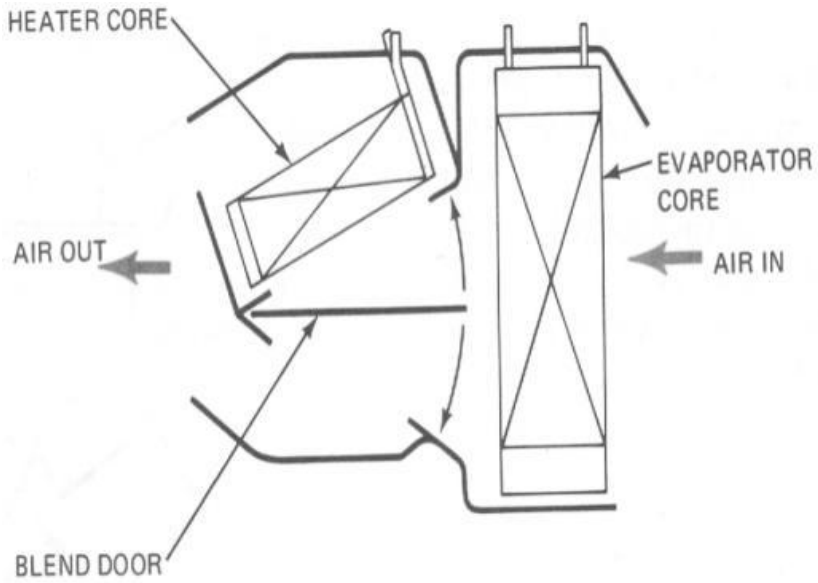
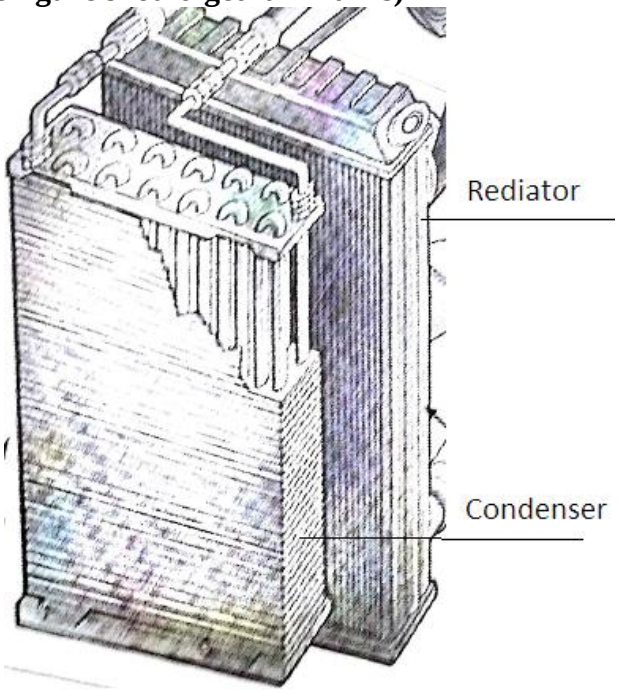
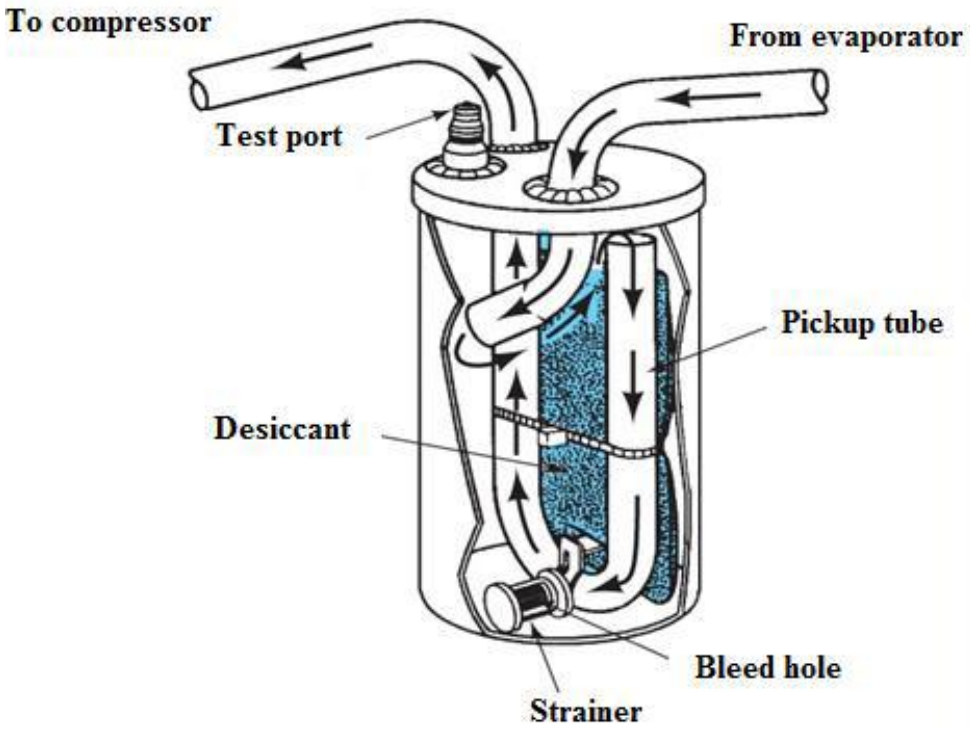
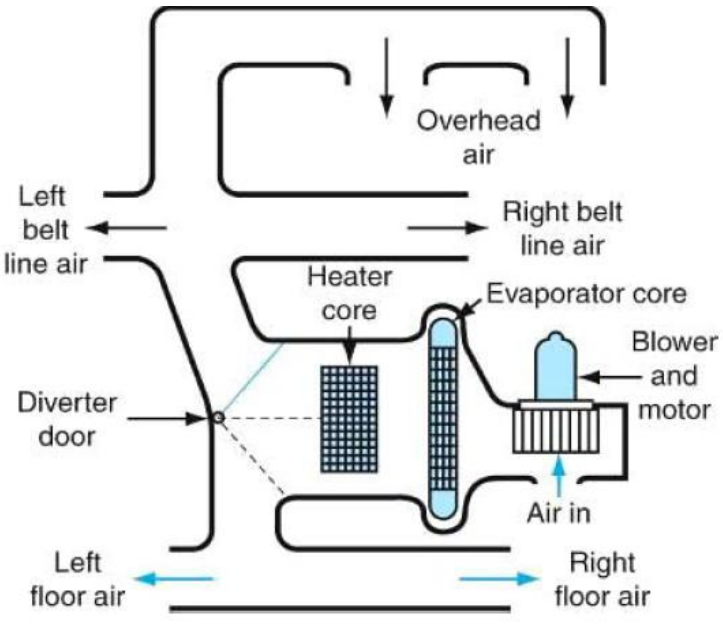
Important Instructions to examiners:

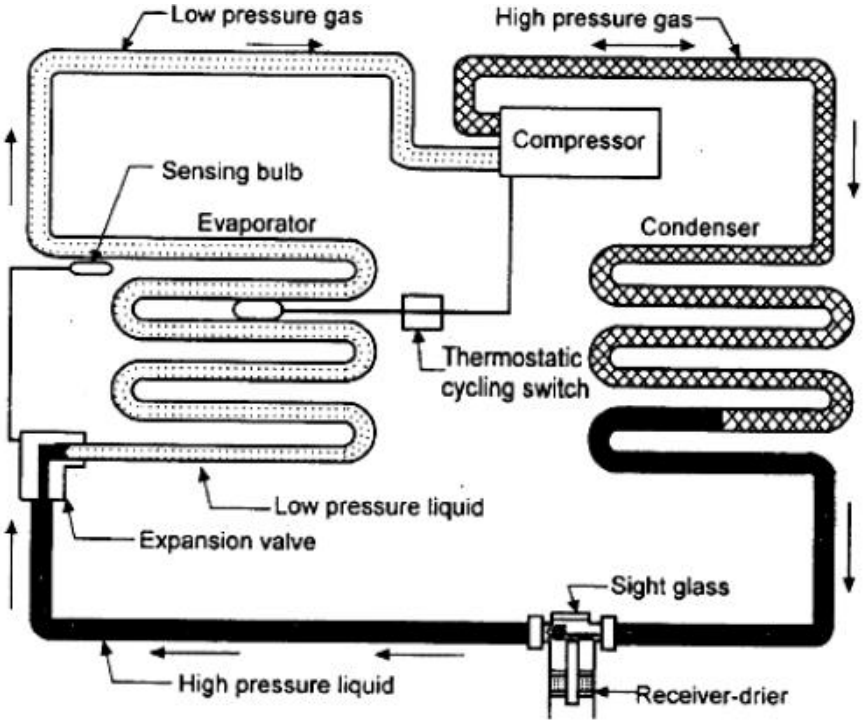
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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.

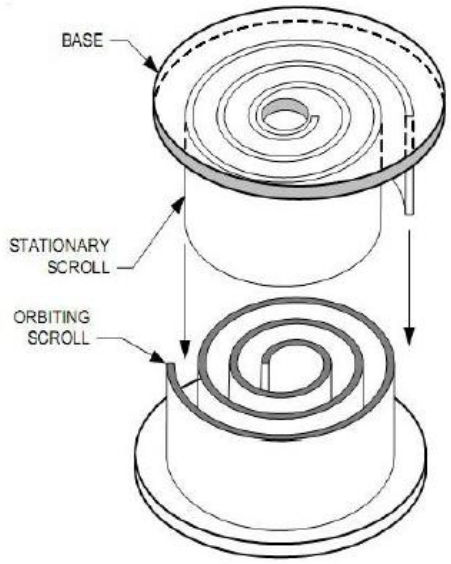
Q. No.	Sub Q. N.	Answer	Marking Scheme
1	a)	**Attempt any THREE of the following:**	12
	i	**Explain uncontrolled and controlled ventilation**	4
		Answer: There are two methods of ventilation available such as uncontrolled ventilation and controlled ventilation. **1. Uncontrolled ventilation:** Uncontrolled 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. 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. **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.	2 2
	ii	**Explain with neat sketch core section.**	**4**
		Answer:- 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	**2**

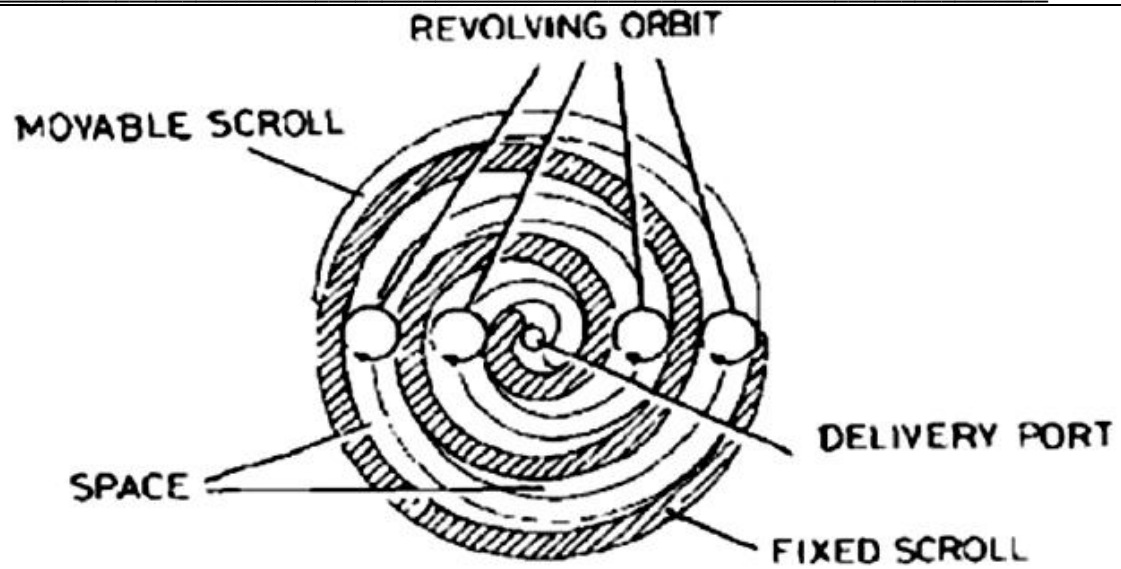
		operated, provides full range control of airflow either through or bypassing the heater core. All air passes through air-conditioning evaporator. In this section full range temperature conditions are provided for in-car comfort  	2
	iii	**Describe construction and working of condenser.**	**4**
		Answer: (Any suitable figure should get full marks)  **Figure: Condenser**	**2**

		Construction: Sketch shows the construction of condenser used for automobile air condition. It is the other heat exchanger used in automobile air conditioning. These are usually made of aluminum or sometimes made of copper or brass. It look very much like radiator, just little thinner and since they also depend on air flowing through them, they are usually located in front of radiator as shown in the figure above. Condensers can be constructed as a series of tubes with fins around them. **Working:** Its main function is to condense the refrigerant vapour from compressor. The refrigerant enters the condensers as a high pressure vapour, but as it flows through the condenser refrigerant rejects the heat to flow air over it and gets converted into high pressure refrigerant liquid.	**1** **1**
	iv	**Explain with neat sketch accumulator.**	**4**
		Answer: Unlike the receiver-drier, which is mounted on the high side of the system, the accumulator is located on the low side of the system, usually right at the evaporator outlet. However, its two-fold function - to store excess refrigerant and remove moisture from the system - is the same as that of the receiver- drier. If any liquid refrigerant is passed out of the evaporator, it's stored by the accumulator. Because liquids cannot be compressed, liquid refrigerant can damage the compressor. And, like the receiver-drier, the accumulator also utilizes desiccant to remove moisture from the system.  **Figure: Accumulator**	2 2

	b)	**Attempt any ONE of the following.**	**6**
	i	**State the requirement of HVAC system in Automobile Sector.**	**6**
		Answer: 1. Each car shall be equipped with two identical units to provide heating, ventilation and air conditioning (HVAC) to the car; The HVAC units shall be removable and self-contained and shall utilize scroll compressors and R400- series refrigerants for cooling. 2. Temperature control shall be provided by a microprocessor based integrated HVAC control system that monitors ambient outside and inside temperature and adjusts the system's cooling and heating functions to maintain a comfortable inside temperature and humidity level throughout the range of environmental and climate conditions. 3. Dampers on the fresh air intake vents shall control the amount of outside air taken in by the HVAC system. 4. Diversion dampers at each end of the car shall control the amount of conditioned air being delivered to the upper or lower level, to adjust and maintain equal temperatures on both levels. 5. Heating shall be provided by over head heat in the HVAC units, with additional heating provided by floor heaters along the base of the sidewalls in the car interiors. 6. Freeze protection shall be provided on the side door thresholds and all fresh water system components that may be exposed to freezing conditions.	**1 mark each**
	ii	**Explain with neat sketch Rear Heating System.**	**6**
		Answer:  **Figure – Rear heating System** **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.	4

		Depending on design it may have 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 heater core is located at the rear of passenger compartment. Driver controls overall operation. Some system sallows 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.	2
2		**Attempt any FOUR of the following:**	**16**
	a	**Draw layout of Automobile Air conditioning system.**	**4**
		Answer:  	4
	b	**State any four desirable properties of Refrigerant.**	**4**
		Answer: **Desirable Properties of a Good Refrigerant:** **1) Thermodynamic Properties:-** a) It should have Low Boiling Point. b) It should be below the evaporator temperature. c) It should be above atmospheric pressure. d) It should have low condensing pressure. e) It should have high latent heat of vaporization. f) It should be above the condensing temperature & pressure.	**Any four properties- 1 mark each**

		2) Chemical Properties:- a) It should not be Poisonous or injurious. It should not be non-irritating to eyes. b) It should not be corrosive & should not have any effect on materials used in equipment. c) It should have fewer tendencies to leak & if it is leaking it should be easily detectable. d) It should not be Inflammable. **3) Other Properties:-** a) It should be easy & safe to handle. b) It should have high specific heat in liquid state and low specific heat in vapour state. c) It should have high COP & low power requirement.	
	c	**Explain construction and working of scroll compressor.**	**4**
		Answer: **Construction of scroll type compressor:** Constructional features of scroll type compressors are as shown in the figure. It consists of refrigerant temperature sensor, moveable scroll, delivery port, intake port, low pressure service valve, front plate, needle bearing, stud pin, crankshaft, eccentric bushing, ball coupling, and fixed scroll etc. **Working:** Scroll-type compressors have two metal scrolls, one fixed and one moveable, which provide an eccentric motion. As the compressor shaft rotates, an eccentric bushing on the shaft drives the moveable scroll, and refrigerant is forced against the fixed scroll, and towards its center. The motion creates an increase in pressure toward the center of the scroll. The refrigerant vapor moves in a circular pattern, and its pressure is increased as it moves toward the center of the scroll. The high pressure refrigerant is released through a delivery port located at the center of the scroll. Scroll-type compressors provide a longer effective compression stroke, and a smoother start-up than other compressor designs, and they produce less vibration.  OR	**1** **1** **2**



(Any suitable figure should get full marks)

d **Explain 'Electromagnetic clutch' with neat figure.** **4**

Answer:

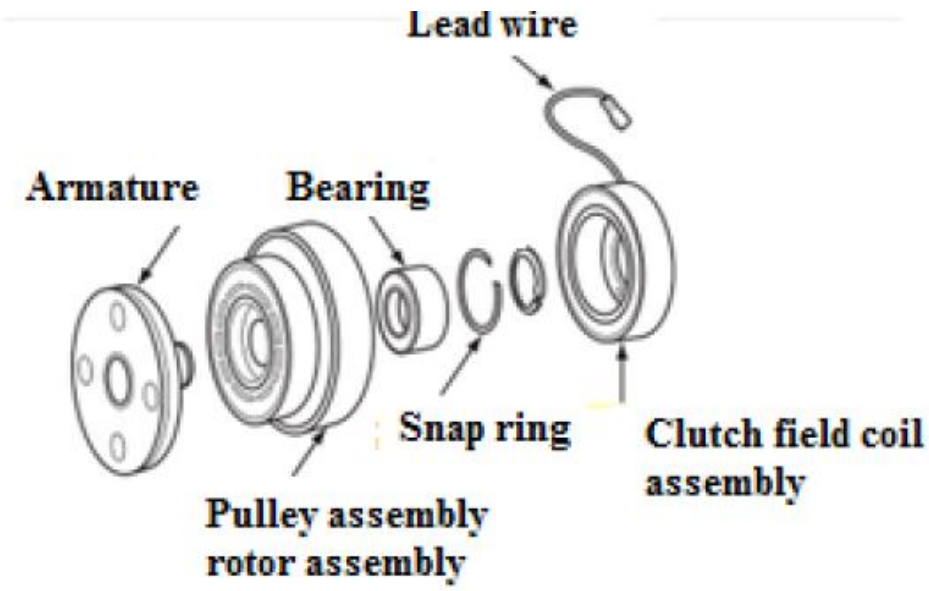
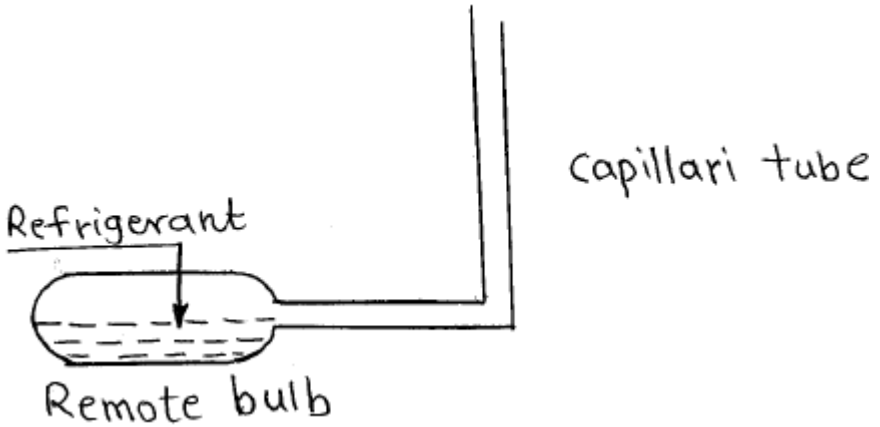


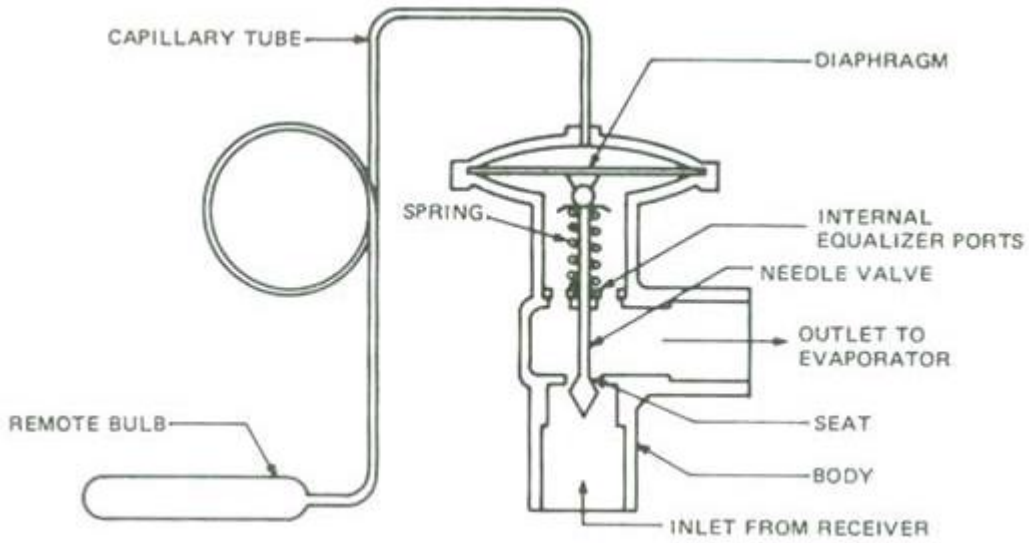
Figure: Assembly of electromagnetic clutch

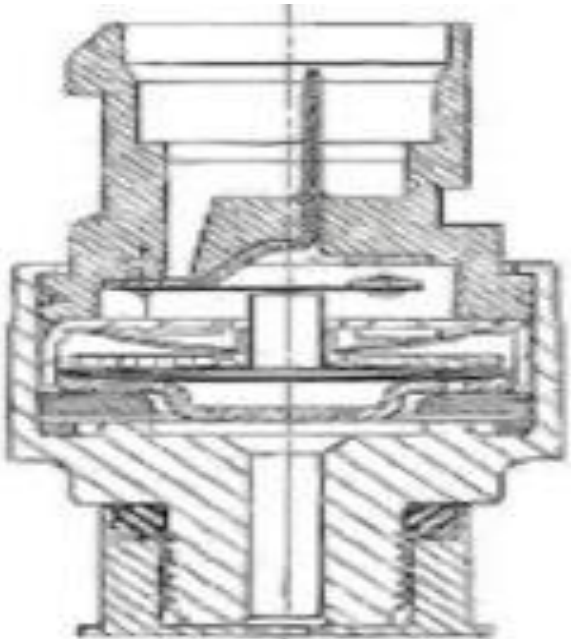
2

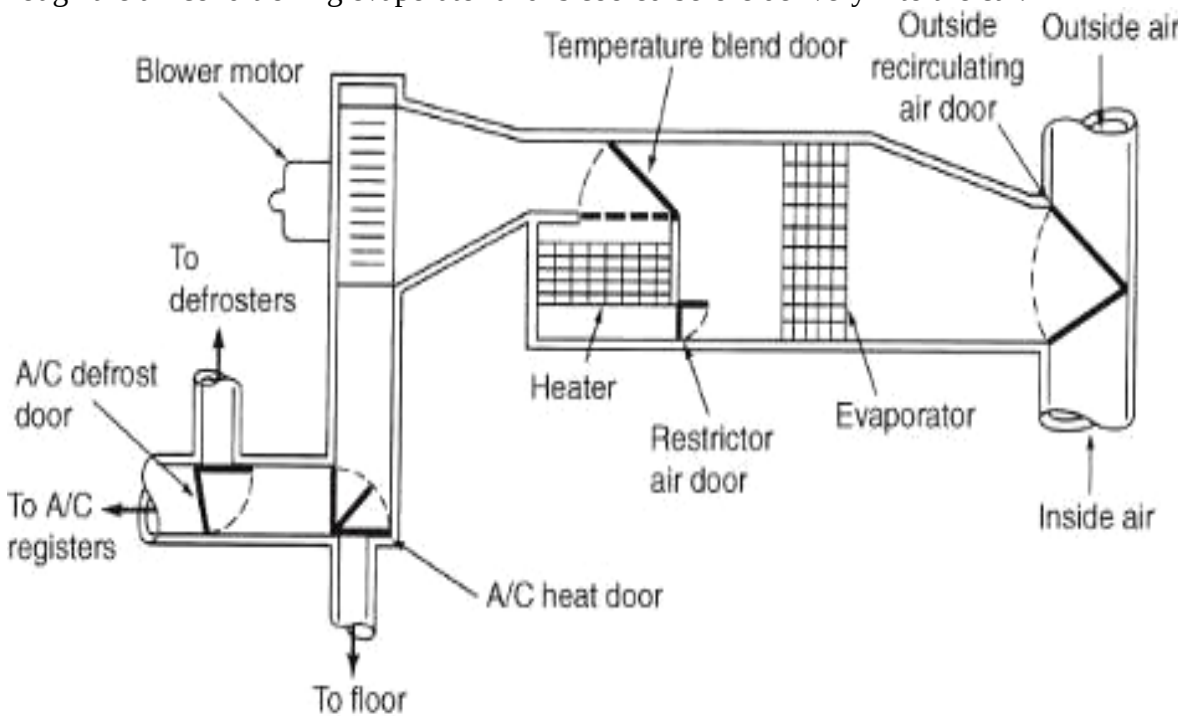
The air conditioning compressor has an electromagnetic clutch that can engage or disengage the compressor pulley. The compressor pulley always turns when the engine is running, but

		the compressor only runs when the pulley is engaged to the compressor driving shaft. When this system is activated, current runs through the electromagnetic coil. The current attracts it to the armature plate. The strong magnetic pull draws the armature plate against the side of the turning pulley. This locks the pulley and the armature plate together; the armature plate drives the compressor. When the system is deactivated, and current stops running through the electromagnetic coil, flat springs pull the armature plate away from the pulley. The magnetic coil does not turn since its magnetism is transmitted through the pulley to the armature. The armature plate and hub assembly are fastened to the compressor drive shaft. When it's not driving the compressor, the clutch pulley turns on a double row of ball bearings	2
	e	**Describe construction and working of 'Remote Bulb'.**	**4**
		Answer: **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. **Working-** As temperature of refrigerant at the outlet of evaporator increases, the temperature in the remote bulb also increases and get vaporized and vapour exerts pressure on diaphragm and diaphragm get open.  	**1** **2** **1**
	f	**State general faults and their remedies in comfort heating system.**	**4**
		Answer: (Any 2 points) **Little or no heat: Causes:** a. Air circulation not enough. b. Air in the heater core. c. Heat core is clogged d. Thermostat of engine cooling system is stuck open. **Remedies:** a. Blower motor or switch is at fault. Temperature door or cable may be adjusted. Leakage of air from heater housing may be stopped. b. Bleed air out. c. Core should be repaired or replaced. d. Replace the thermostat. **2. Defrosting insufficient: Causes:** a. Control cable of defrost door is out of adjustment. b. Defrost outlets blocked. **Remedies:** a. Cable should be readjusted. b. Remove the obstructions	

3		**Attempt any FOUR of the following:**	**16**
	a	**Explain 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. ***Example of conduction:*** When solid bar of metal is heated from one end, we find other end of the metal is getting hot **Convection heat 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	**Only Names 2 marks & suppo rted by defina -tions 4 marks**
	b	**State safety aspects in HVAC system.**	**4**
		Answer: Safety aspects-(any4) 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 equipments should not be pressure tested or leak tested with compressed air.	4
	c	**Explain 'Thermostatic expansion valve' with neat sketch.**	**4**
		Answer: The capillary tube, tube end and upper diaphragm chamber form a closed system filled with a temperature sensing gas. (Refrigerant- carbon dioxide, similar gas). The capillary remote bulb is clamped on to the evaporator outlet pipe and it is insulated from the outside air with special tape and it measures only the temperature of refrigerant, as it leaves the evaporator. Any increased in refrigerant temp. at the evaporator outlet increase the pressure in the remote bulb & tube system. This exerts downward pressure on the diaphragm is greater than the combination of the evaporator pressure & the superheat spring pressure, as a result valve is open and increase flow of refrigerant to evaporator coil. As the temp. of refrigerant decrease, it decreases pressure in the remote bulb and tube system. This decreases pressure on the diaphragm & this pressure less than combination of evaporator pressure and superheat spring pressure and allowing the valve tube close and control flow of refrigerant to the evaporator coil.	2

		 **Figure- Thermostatic Expansion valve**	2
	d	**Explain procedure of charging and discharging of A/c system.**	**4**
		Answer: **Procedure of charging:** 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 carefully 16. Install protective caps on valves. 17. As final check use the leak detector and check for leaks. **Procedure of discharging:** 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: 1. Attach gauge set in place.	**2**

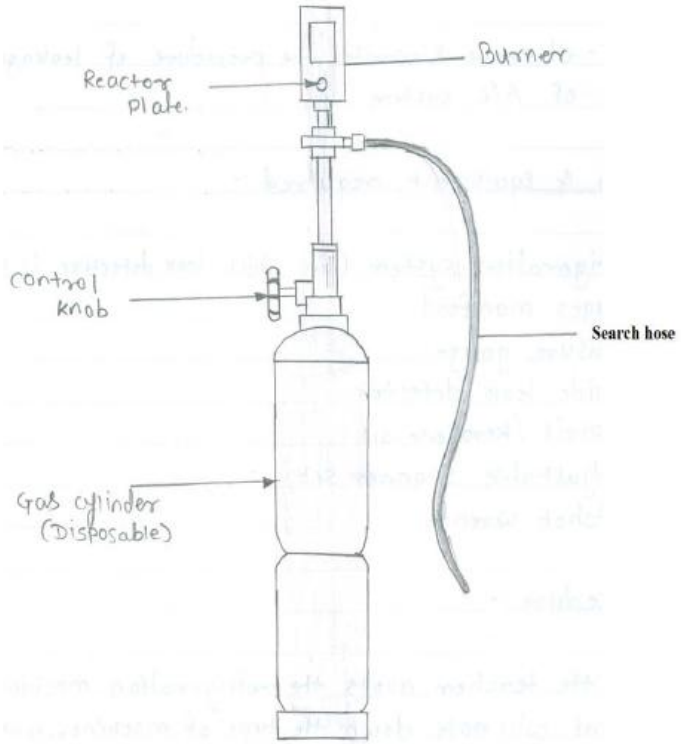
		2. Place centre hose of gauge set into floor exhaust outlet or near the floor in well-ventilated area. 3. Open high pressure gauge valve slowly so that refrigerant should escape through centre hose of gauge set. 4. Regulate flow of discharge so that very little oil is observed coming out of the centre 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
	e	**Explain construction and working of high pressure switch.**	**4**
		Answer: : Construction and working of High pressure switch: **High pressure control switch consists of following main parts-** Knob (for adjusting cutout and differential), lock plate, tension spring, compression spring, diaphragm, lever, main body, return spring, retaining spring, electrical contacts, scale, inlet connection. The high pressure cutout used in refrigeration unit is connected to the high pressure side of the compressor or to line between the compressor and the condenser. **Working:** 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**	1 1 2

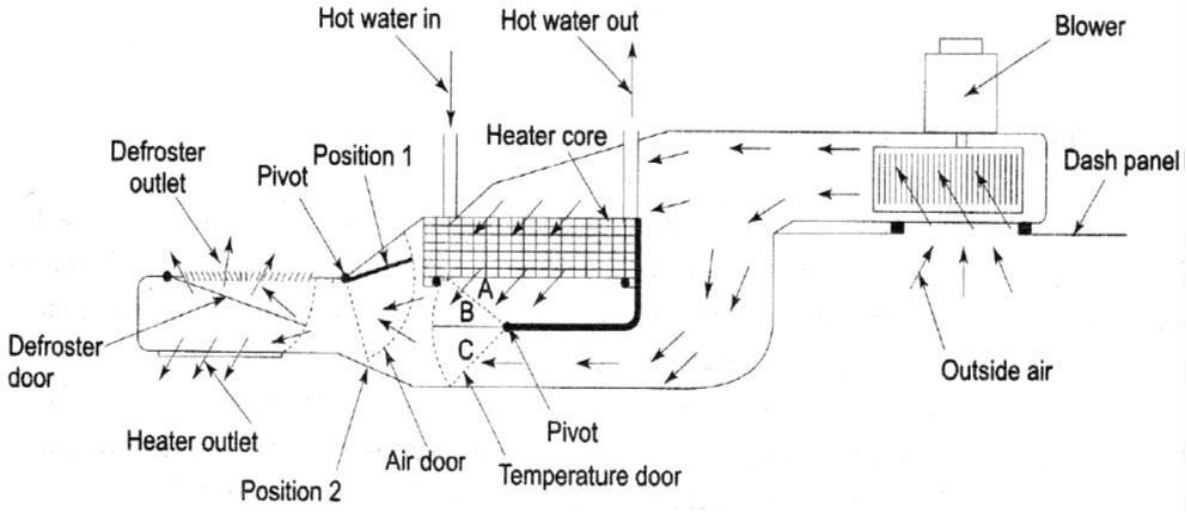
4	**a**	**Attempt any THREE of the following:**	**12**
	i	**Explain construction and working of downstream duct system.**	**4**
		Answer: **Construction:** A schematic sketch of independent case system with downstream blower is as shown in the following figure. It consists of fresh (outside) air inlet, a re-circulate (inside) air inlet, fresh / re-circulates air door, evaporator, heater, temperature blend door, restricted air door, blower motor and conditioned air outlets for defrosters, panel, floor etc.	**1**
		Working: The heater water valve is open to allow hot engine coolant to flow through the heater core. Cool outside fresh air is heated as it passes through the heater core. The air conditioner is not operational; therefore, it has no effect on the air temperature as the air first passes through evaporator. The desired temperature level is achieved by the position of the blend door. This allows a percentage of the cool outside air to bypass the heater core. The heated air and cool air are then blended in plenum to provide desired temperature level before passing on to the air distribution section. From the plenum this air is passed to distribution section with the help of blower. Depending upon the position of mode door conditioned air may be delivered to the floor outlets, the defrost outlets, or the dash panel outlets, or any combination of outlets. In other than maximum cooling (MAX A/C), fresh outside air passes through the air conditioning evaporator and is cooled before delivery into the car.	**1**
		 **Figure: Independent case system with downstream blower**	**2**

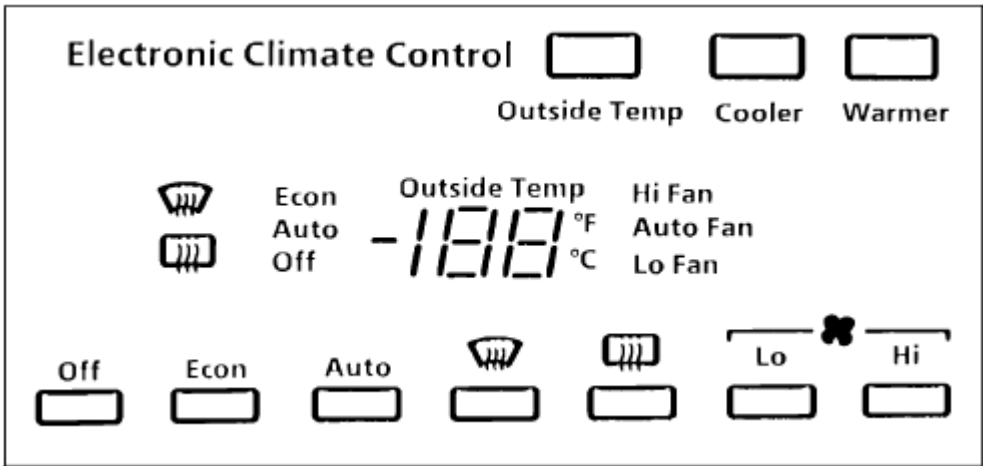
	ii	**Compare Thermostatic expansion valve and fixed orifice tube on any four aspects.**	**4**
		Answer: (Any four)	**4**

Sr.	Thermostatic expansion valve	Fixed orifice tube
01	It has moving parts	It has no moving parts
02	A system with thermostatic expansion valve has drier/receiver	A system with fixed orifice tube has no drier/receiver
03	The drying agent for the system is found in separate drier.	The drying agent for the system is found in an accumulator
04	Refrigerant flow through the thermostatic expansion valve is controlled by a spring-loaded valve	Refrigerant flow through the fixed orifice tube is controlled by a orifice tube
05	Refrigerant flow through spring loaded valve is controlled by pressure difference above and below the diaphragm	Refrigerant flow through fixed orifice tube is controlled by pressure difference and sub cooling characteristics of refrigerant.
06	High initial & Maintenance Cost	Low initial & Maintenance Cost

	iii	**Explain with neat sketch 'Halide Leak Detector'**	**4**
		Answer: Halide leak detector as shown in figure can detect a leak as slight as 0.4536kg in ten years. This instrument is popular because of its low initial cost, ease of handling and simplicity in construction and operation. It consists of two major parts; the detector unit and the gas cylinder. The gas cylinder is a non refillable pressure tank containing a gas such as propane or butane. The detector unit consists of valve, the burner and the search hose. After igniting the gas and air mixture, the flow of gas is regulated until the flame burns about 6mm above the opening in the reactor plate. The plate is heated by flame to red hot temperature. When search hose comes into contact with leaking refrigerant, the refrigerant is drawn into the search tube and is brought to the receiver plate, where different colour flames are produced. in the burner. If the flame colour is blue, there is no leak, if the flame colour is yellow-green the leak is small, if the flame colour is bright blue purple the leak is large. If the leakage is severe, the flame is put out.	2

			2
	iv	**State function and location of 1) sun load sensor and 2) outside temp. sensor**	**4**
		Answer:- 1) sun load sensor: The sun load sensor is a photochemical diode (PCD) located on top of the dashboard. This sensor send signal to the electrical climate control module (ECCM) indicating the strength of the sunlight (sun load) which influences the vehicle interior temperature. If the sun load is high as signaled by the sun load sensor the ECCM will activate the highest lower fan speed and max cooling to compensate for this additional radiated heat load. Likewise if the sun load is low (cloud cover) as sensed by the sun load sensor the ECCM will reduced the blower fan speed and the system will not operate at max cooling **2) Outside temp. Sensor:** It is usually located just behind the radiator grille and in front of condenser. Its purpose is to sense the outside temperature condition to provide data to processor. This sensor circuit has several programmed memory features to prevent false ambient temp data input during the period of low speed driving or when stopped such as when waiting for traffic control	**2** **2**
4	**b**	**Attempt any ONE of the following:**	**6**
	i	**Explain working of 'Comfort Heating System' with neat sketch.**	**6**
		Answer: The comfort heating system in vehicle is able to provide desired air temperature inside the vehicle. It operates with ventilating system. Figure shows comfort heating system in a vehicle. It consists of heater core which is a small radiator as like engine radiator. Hot coolant from the engine is circulating through this heater core by using engine water pump. This heats the heater core. Air from the outside flows through the heater core air passages.	**2**

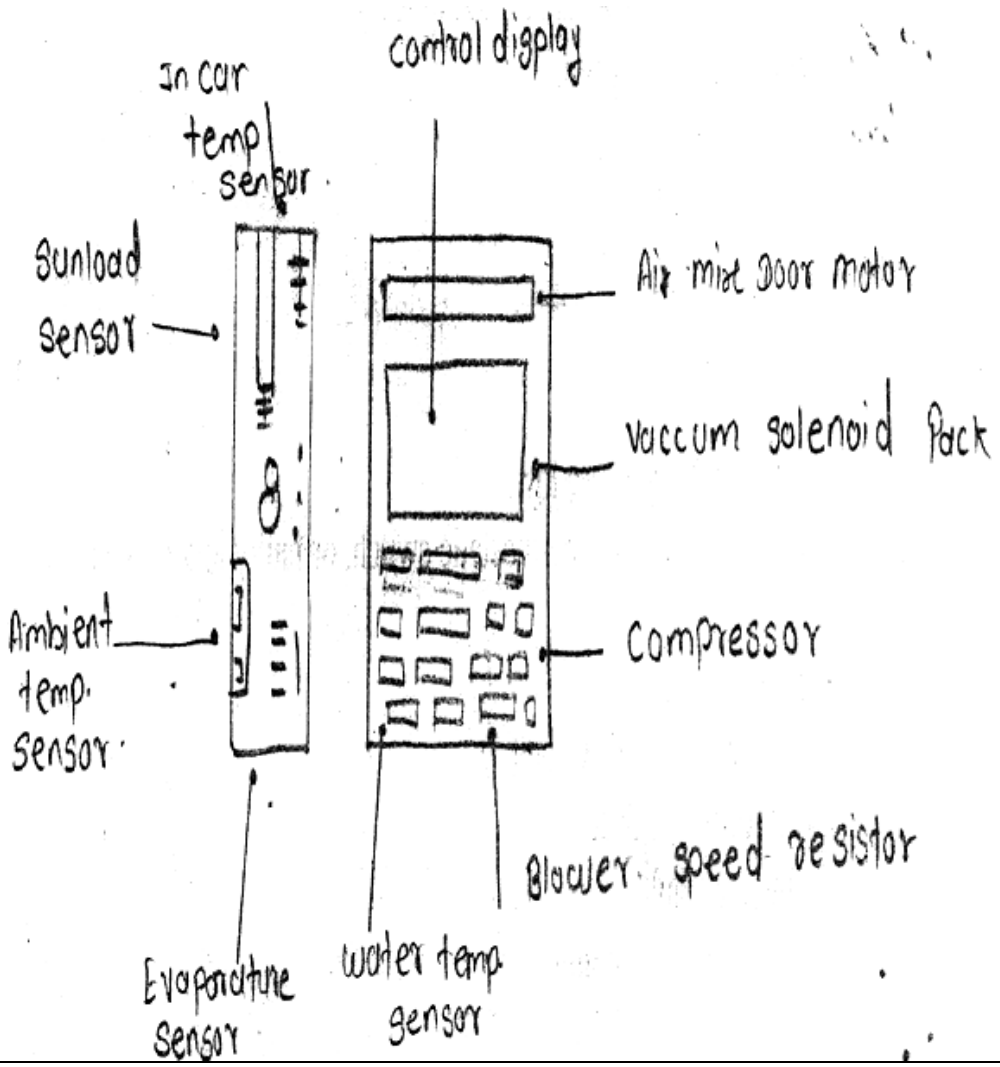
		This heats the air. This heating system has three doors- 1. Temperature door- It is used to permit more or less air to flow through heater corer. 2. Air door- It can be operated to allow full air flow or no air flow or any position in between. 3. Defroster door- It can be used to supply the heated air on the inside of the windshield or to the outlet of the heater in the car. All these doors are operated manually by control levers or knobs on the instrument panel.  **Figure: Comfort Heating System**	**4**
	ii	**Explain with (neat sketch) block diagram Electronic Climate Control System.**	**6**
		Answer: **Climate Control:-** The electronic climate control (ECC) System offers automatic control of the front and rear rooftop air conditioners and furnace/s in the motor home. The system includes an energy management system that shuts off the air conditioners when necessary to prevent electrical over load. It also includes a number of features that provide the owner with the most comfortable temperature controlled environment possible. Working: The System contains two major components, the ECC Thermostat and the ECC module, along with additional external sensors which are connected to these modules. The Thermostat allows the owner to set the front and rear air conditioning and heating systems' modes and temperatures. The electronics in this panel measure ambient temperatures via two external temperature probes (front and rear). Based on the mode and set point temperature settings, the probes send appropriate control signals to the ECC module. The Control Module performs the timing, sequencing, switching, and load shedding functions for the furnace/s and air conditioner fans and compressors. It is often located under the refrigerator.	**2**



4

Note: Credit shall be given to any other suitable sketch)

OR



5		**Attempt any Four of the following**	**16**
	a)	**Explain construction and working of Vacuum motor.**	**4**
		Answer: Construction and working of vacuum motor:	**02**

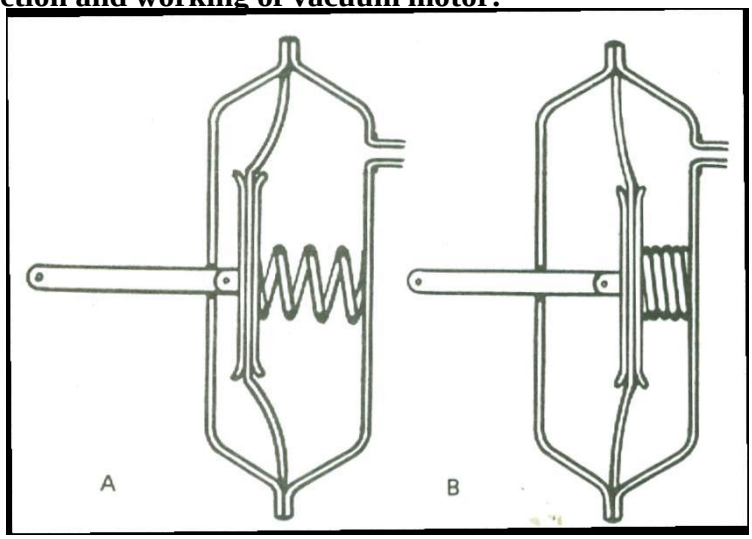


Fig. Vacuum motor

Construction and working of vacuum motor:

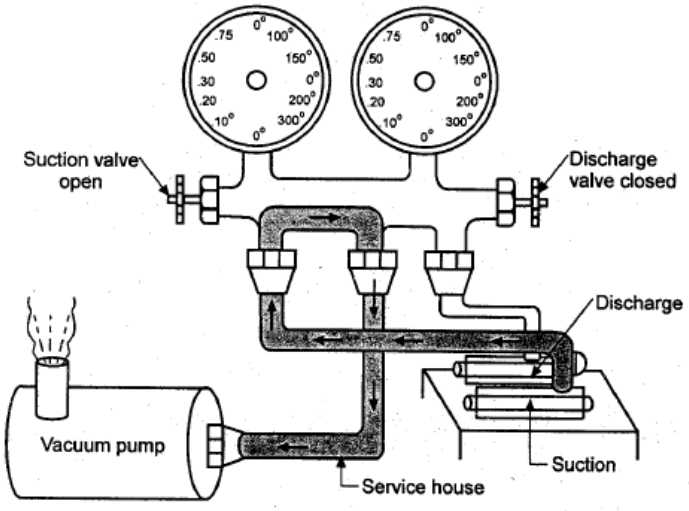
To activate the mode doors so as to bring the change in condition vacuum motor is used. The vacuum motor is also known as vacuum pot. Figure shows how vacuum motor is used to operate the mode doors. In figure A the device shown in relaxed position. In figure B it is in applied position. In the relaxed position, the spring keeps the arm extended. In the applied position, the vacuum overcomes the spring pressure and is pulled to IN position. The normal or OFF position of the vacuum motor is the relaxed position. **02**

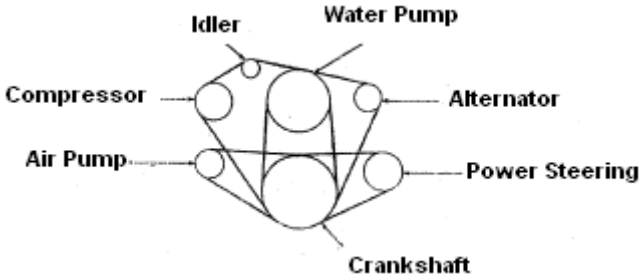
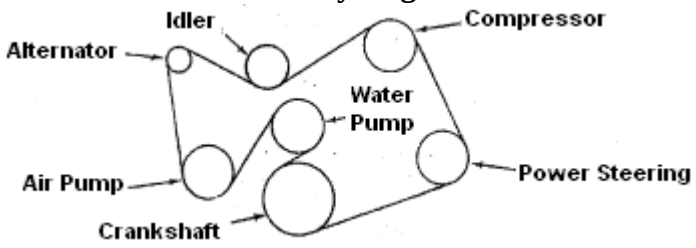
b) State cause of fault and remedy of compressor.

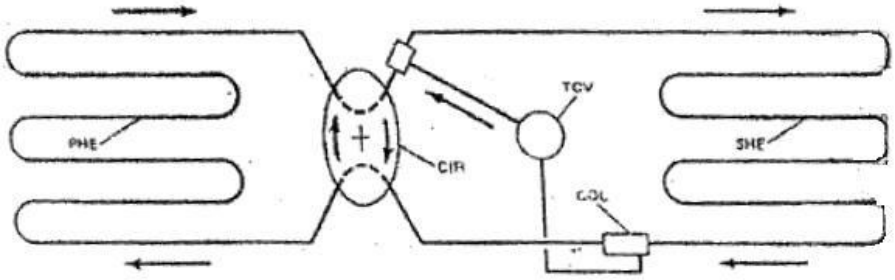
(Any four)

	Fault	Causes	Remedies
1	**Noise in compressor**	Loose Components	Tightening
		Lack of oil	Replenish the oil level and check the bearings
		Piston	Check debris on piston
		Loose floor mounting	Tightening of bolts
2	**Compressor not working**	Broken belt	Replace belt
		Broken clutch wire	Repair wire
		Bad thermostat	Repair thermostat
		Bad clutch coil	Repair
3	**Low Compressor discharge pressure**	Leakage system	Repair leakage
		Defective expansion valve	Repair valve
		Suction valve closed	Open it

		4	**High compressor discharge pressure**	Air in system	Recharge system	
				Clogged condenser	Clean condenser	
				Discharge valve closed	Open valve	
		5	**Low suction pressure**	Refrigerant shortage	Add refrigerant	
				Worn compressor piston	Replace compressor	
				Compressor suction valve leaking	Change valve	
		6	**High suction pressure**	Loose expansion valve	Tighten valve	
				Overcharged system	Remove some refrigerant	
				Expansion valve stack open	Replace expansion valve	
	c)	**Explain Leak Test and Temp. Test of A/C system.**				
		Leak Test 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. 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. **Procedure:** 1. Install the gauges and gauge manifold. Note the pressure and temperature in the beginning. 2. Close the manifold valves A and B. 3. Now attach the refrigerant cylinder at the centre of the gauge manifold. Do not open the refrigerant cylinder valves. Do not operate compressor. 4. Start halide/freon leak detector. 5. Now open the refrigerant cylinder valve. 6. Open gauge manifold valves A and B slowly raising the pressure to about 1.75kgf/cm2. 7. Check the leaks with torch. Any leak detected should be repaired properly. 8. Raise the system pressure to about 3.75kgf/cm2 and check leaks at every joint and surface. If any leak is found place should be repaired immediately. 9. Now, raise the pressure to about 5.0kgf/cm2 in the gauges and check the leaks in the system at various joints, surfaces and repair the leaks. 10. If the flame colour is blue, there is no leak, if the flame colour is yellow-green the leak is small, if the flame colour is bright blue purple the leak is large. If the leakage is severe, the flame is put out. 11. Close refrigerant cylinder valve after completing the job, close gauge manifold valves A and B. **Temp. Test of A/C system.** Connect manifold gauge set at high and low side valves 1. Turn on engine and allow temperature to reach 210C or high. 2. Take tachometer and run engine at 1500rpm.				**02** **02**

		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.	
	d)	**Explain working of typical vacuum system.**	**04**
		Working of typical vacuum system: The A/c system must be evacuated whenever the system is serviced. Evacuation rids the system of all air and moisture that was allowed to enter the unit. The various components used in vacuum system are reserve tank, check valve, vacuum pump and vacuum motor. Connection for evacuation of system is shown in figure. Whenever opened, a/c system must be evacuated by using a vacuum pump. Connect low and high charging hoses of manifold gauge set respectively as follows- High charge hose ⟶ Compressor delivery hose Low charge hose ⟶ Compressor suction hose Attach central charging hose of manifold gauge set to vacuum pump. Operate vacuum pump and then open suction side valve of manifold gauge set. If there is no blockage in the system, there will be an indication on high pressure gauge. When this occurs, open the other side valve of the set. Approximately 10 minute later, low pressure gauge should show a vacuum lower than 760 mm of Hg providing no leakage exists. Evacuation should be carried out for a total of at least 15 minutes. Continue evacuation until low pressure gauge indicates vacuum less than 760mm of Hg and then close both the valves. Stop vacuum pump, disconnect central charging hose from pump inlet. Now the system is ready for charging refrigerant.  **Fig.** Vacuum system	**02** **02**
	e)	**Explain the drive system for compressor in automobile air conditioning.**	**04**
		Drive system for compressor in automobile air conditioning: 1. **Compressor driven off crankshaft pulley by one or two belts:** Compressors are driven by one or two belts of the engine crankshaft and have an idler pulley which is used to adjust the belt tension. Similarly, alternator or power steering pump can be used to adjust	**2**

		belt tension  Figure: Compressor driven off crankshaft pulley by one or two belts OR 2. **Compressor driven off crankshaft by single belt:**  **Figure: Compressor driven off crankshaft by Serpentine belt** Compressor can be driven off the crankshaft by single belt drive along with such other accessories as power steering pump, air pump, alternator and water pump. This system is known as serpentine drive as shown in figure. The belt called V-rib or serpentine is tensioned by spring loaded idler pulley which rides on the back side of the belt.	**2** **2** **2**
	f)	**Describe fluorescent leakage detector.**	**4**
		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**

6		**Attempt any Four of the following**	**16**
	a)	**Explain working of rotary vane air cycle system with neat sketch.**	**04**
		Working of rotary vane air cycle system:  **COL - Collector** **SHE - Secondary heat exchanger** **CIR - Circulator** **TCV- Temperature Control Valve** **PHE - Primary heat exchanger** **Figure: Rotary vane air cycle system** The compressor of ROVAC system is called circulator. The condenser is called primary heat exchanger. The collector in the system serves in similar manner as an accumulator in conventional system. It separates liquid (hydrocarbon) from vapour (air). Unlike accumulator however the liquid is retained in the collector & is not metered back into the system. A small amount of oil circulates in the system at all times to provide lubrication for the circulator. Other liquid comprised of & hydrocarbons are vaporized in secondary heat exchanger as it pick up heat. Conversely this vapour changed back to the liquid in primary heat exchanger as its heat is given up to the outside air.	**2** **2**
	b)	**State the concept of aspirator and Time delay.**	**04**
		Concept of Aspirator: The aspirator is small duct system which is so designed that it causes small amount of in car air to pass through it, as shown in figure. The main air stream causes low pressure at inlet end of the aspirator. This causes in-car air to be drawn into the in-car sensor plenum. The in-car sensor, located in plenum, is continuously exposed to average in-car air to monitor the in-car air temperature.	**1**

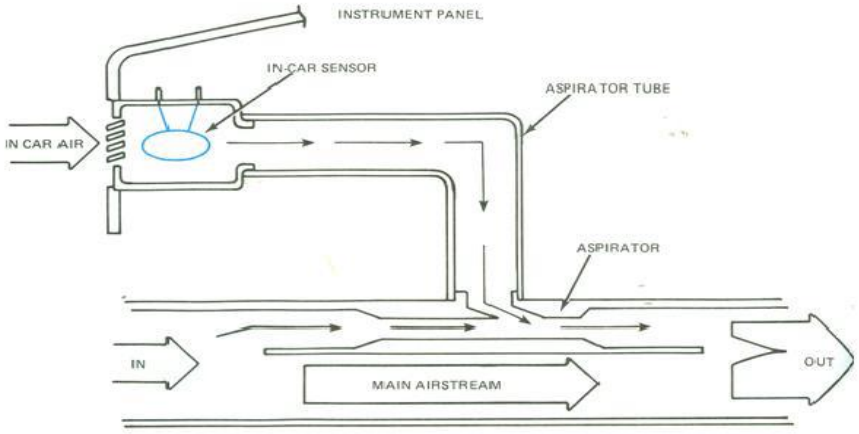


Fig. Aspirator — 1

Concept of Time Delay Relay: The time delay control unit is designed to prevent the heat cycle from coming on in the automatic unit until the engine coolant has reached temperature of 43.34^0C. The unit consists of two resistors, capacitors, and transistors. Following figure shows time delay circuit of the wiring diagram. — 1

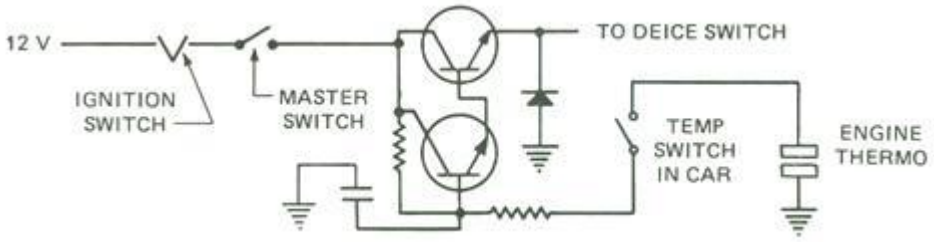
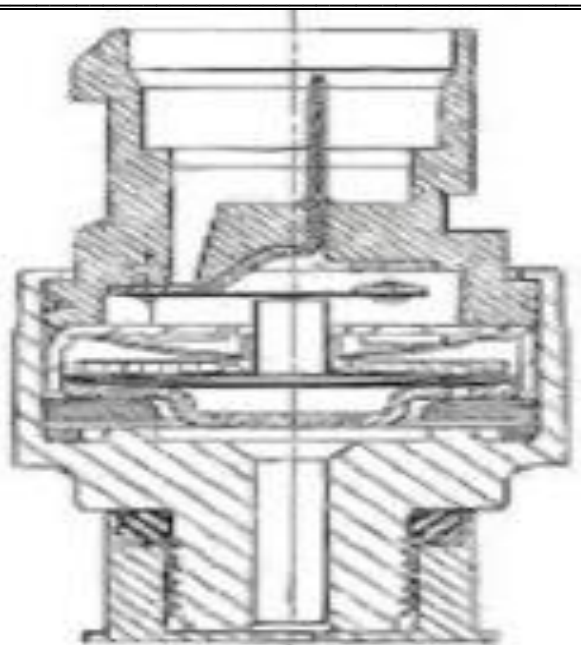
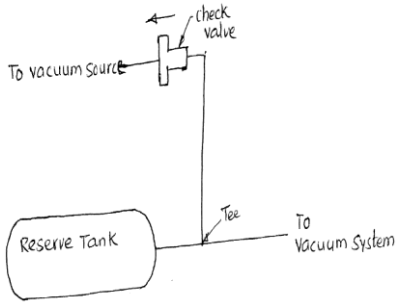


Fig. Time Delay Relay — 1

	c)	**Explain working of High Pressure Switch.**	**04**
		Working of High pressure switch: The high pressure cutout 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.	**2**

		 **Figure**:- **High pressure switch**	**2**
	d)	**Explain construction and purpose of Vacuum Reserve Tank.**	**04**
		Construction and working of Vacuum Reserve Tank: Vacuum reserve tanks are manufactured in variety of sizes and shapes. Those most commonly used resemble large juice can as shown in figure. These tanks require no maintenance but sometimes develop pin bole size leaks due to rust or corrosion. When tank is suspected of leaking it may be removed from car & pressurize to about 34.4 kpa. It is then leak tested with soap solution or by immersion in water tank. After releasing the pressure the hole may be repaired by first cleaning the area to the base metal with sandpaper then applying on epoxy or fibre glass material.  **Figure: Vacuum reserve tank**	**2** **2**
	e)	**Explain working and state location of Check Valve.**	**04**

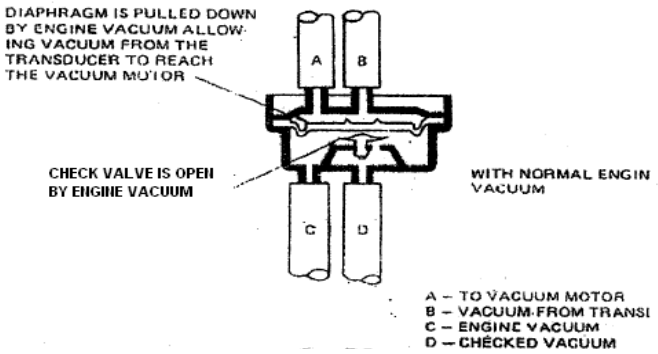


Fig. Check Valve **2**

Working: Whenever the manifold vacuum drops below the valve of reserve vacuum the check valve closes the diaphragm also close and blocks the passage of from control motor. As a result reserve vacuum is not lost because it is not allowed to bleed back through the manifold. The manifold vacuum drops during the period of acceleration and when the engine is stopped. The vacuum reserve is used to operate the air conditioning system vacuum components and other accessory equipment in the automobile such as headlamp, doors, door locks likewise. **1**

Location: Check valve is located in the vacuum line between the reserve tank and the vacuum source. The check valve is opened whenever manifold vacuum is greater than reserve vacuum. In this position the check valve connects the source the tank The normal engine vacuum also opens the diaphragm & allows vacuum from control to reach the vacuum motor. **1**