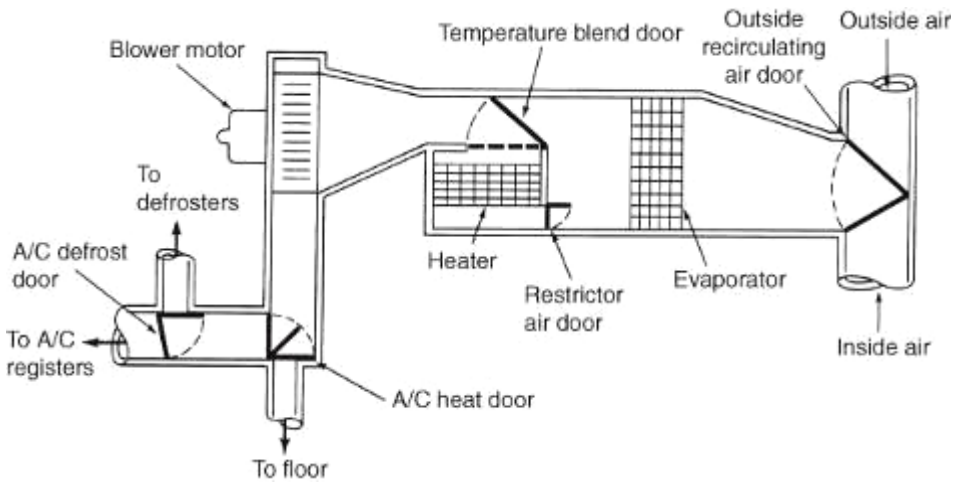
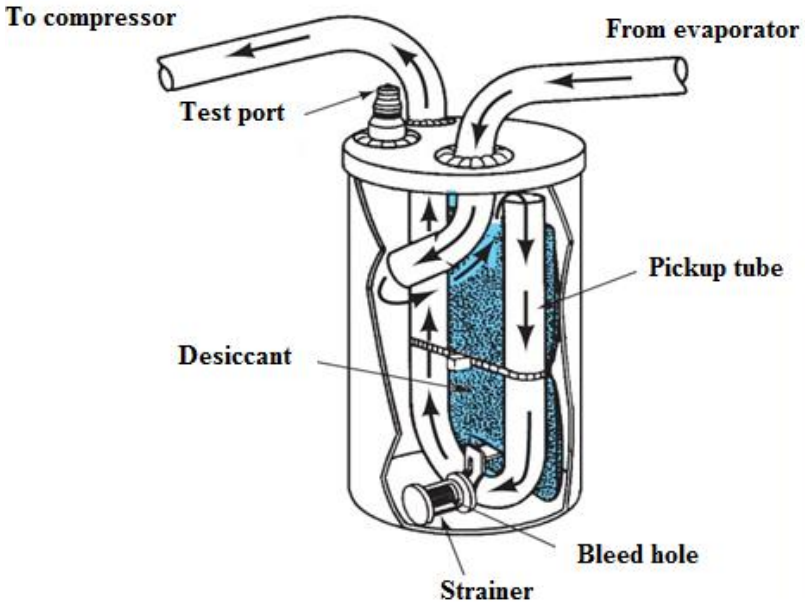
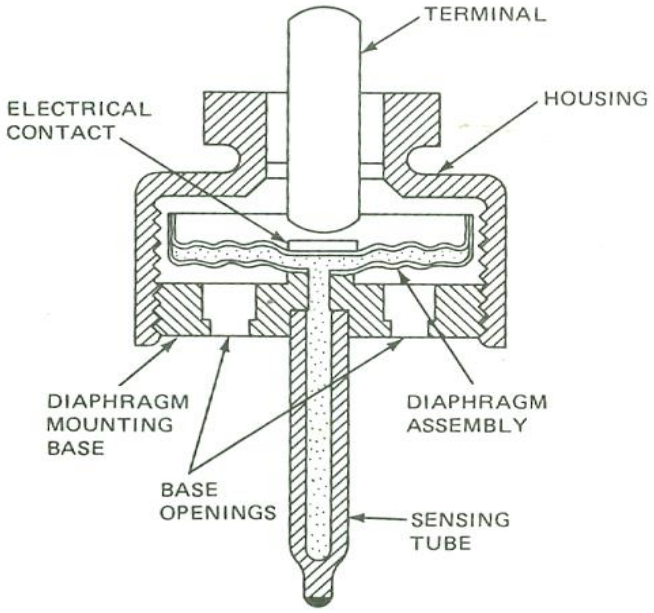
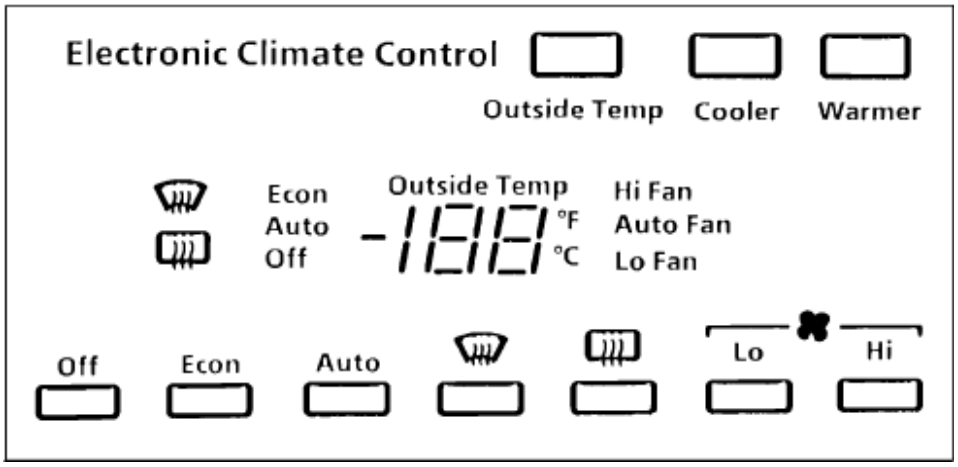
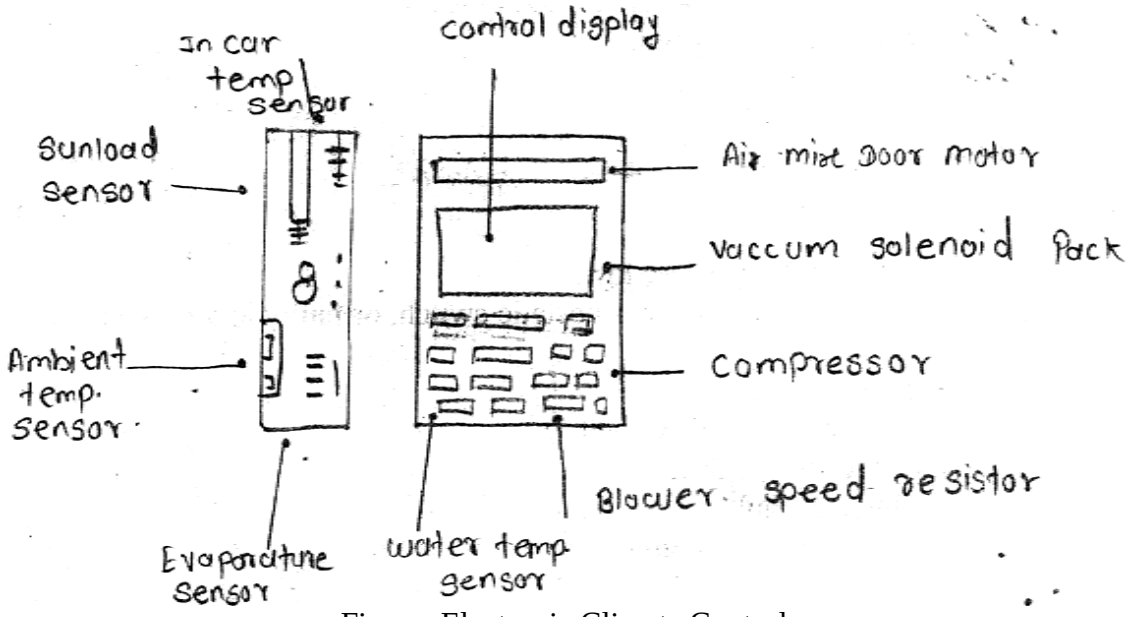
Important Instructions to examiners:
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language 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 THREE of the following.	**12**
i) Describe radiation heat transfer and convection heat transfer.	4
Answer : **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 **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.	2 2
ii) Explain construction and working of downstream duct system with neat sketch.	4
Answer: Construction and working of downstream duct system: **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-circulate air door, evaporator, heater, temperature blend door, restricted air door, blower motor and conditioned air outlets for defrosters, panel, floor etc. **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	1 1

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  **Figure: Independent case system with downstream blower**	2
iii) Explain with neat sketch accumulator.	4
Answer: Accumulator: Figure shows accumulator which consist of inlet pipe, outlet pipe, pickup tube, desiccant, strainer with bleed hole and test port. The accumulator is located on the low side of system, usually at the right side of evaporator outlet. The main functions of the accumulator are- a) To store excess refrigerant and b) Remove moisture from the system. If any liquid refrigerant is passed out of the evaporator it is stored by accumulator because liquid cannot be compressed. Liquid refrigerant can damage the compressor. Like the receiver drier the accumulator also uses desiccant to remove moisture from the system.  Figure. Accumulator	2 2

iv) Describe construction and working of superheat switch.	4
Answer: Construction and working of superheat switch: *(Note: Equivalent credit shall be given to any other suitable sketch)*  **Figure: Superheat switch** **Construction and Working:** The superheat switch is located in the rear head of some six cylinder compressors. This device is a temperature/pressure sensitive electrical switch which is normally in the open position. The switch remains open during the systems high pressure and high temperature conditions or low pressure and low temperature conditions. The switch closes when the system experiences high temperature and low pressure conditions. The high temperature and low pressure condition of the system is usually caused by loss of refrigerant. This loss may result in compressor or system damage if air conditioning system remains in operation. The superheat switch offers a failsafe method of stopping the compressor until the problem is corrected. When superheat switch closes, a circuit is completed through a heater of thermal fuse. The fuse blows, opens the clutch circuit and stops the compressor.	2 2
b) Attempt any ONE of the following:	06
i) State the applications of uncontrolled ventilation and explain its working.	06
Answer: Applications of uncontrolled ventilation: *(Any four applications - 2 marks)* 1. Car window opened for fresh air while moving on road natural or uncontrolled ventilation takes place. 2. Trickle vents and gaps in body. 3. Vehicles in which soft top body is used. 4. Open roof construction allows uncontrolled ventilation e.g Maruti Gypsy. 5. Bus body and truck body. 6. In smaller buildings, operable windows and other openings, exhaust fans, and infiltration are used to provide ventilation air.	2

Working: Uncontrolled ventilation occurs when anyone opens window so that fresh air from outside can enter into the vehicle. This fresh air replace the inside stale air and provides comfort to passengers. This method has been used for years. This type of ventilation depends upon indoor and outdoor temperature difference, wind pressure, location and operation of exhaust system and many other factors. It has the advantage of providing almost any quantity of fresh air quickly. The disadvantage of the system is opening the window allows wind, rain, dust and other air borne particles (i.e. impurities) along with fresh air to enter inside the vehicle. The entry of air is not controlled by suitable valves or doors. This system provides only plenty of fresh air and does not include heater and air conditioning system, may not be useful in all weather conditions.	4
ii) Explain with block diagram electronic climate control system.	06
Answer- Electronic Climate control system: *(Note: Credit shall be given to any other suitable sketch)*  OR  Figure: Electronic Climate Control	2

The electronic climate control (ECC) System offers automatic control of the front and rear roof-top 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. — 4

2. Attempt any FOUR of the following — 16

a) Discuss requirement of HVAC system in light motor vehicle. — 4

Answer : Requirement of HVAC system in light motor vehicle: — 4

Since the atmospheric conditions are changing continuously over a period of a year and are different at various places, the air conditioning of automobiles is very essential. During summer, large amount of heat enters the passenger compartment. This heat comes from air outside the car solar radiation and engine etc. To get comfort the excess heat should be removed. Oftenly in warm and damp driving conditions, the windows of the vehicle fog up to much moisture inside the vehicle. Also in cold seasons heat is required to warm the inside environment of vehicle.

So to meet the above mentioned requirements modern automobiles are equipped with ventilation heating cooling and dehumidification. In most of the vehicles ventilation system is designed to allow fresh air into the passenger compartment, replacing stale air and to prevent entry of polluted air from outside. Hence to maintain human comfort and to provide clean and fresh atmosphere inside the vehicle, air conditioners are used in most of the vehicles.

b) Compare thermostatic expansion valve and fixed orifice tube on any four aspects. — 4

Answer : Comparison: *(Any four points)* — 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.

c) State the concepts of aspirator and time delay relay.	4

Answer:

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. 2

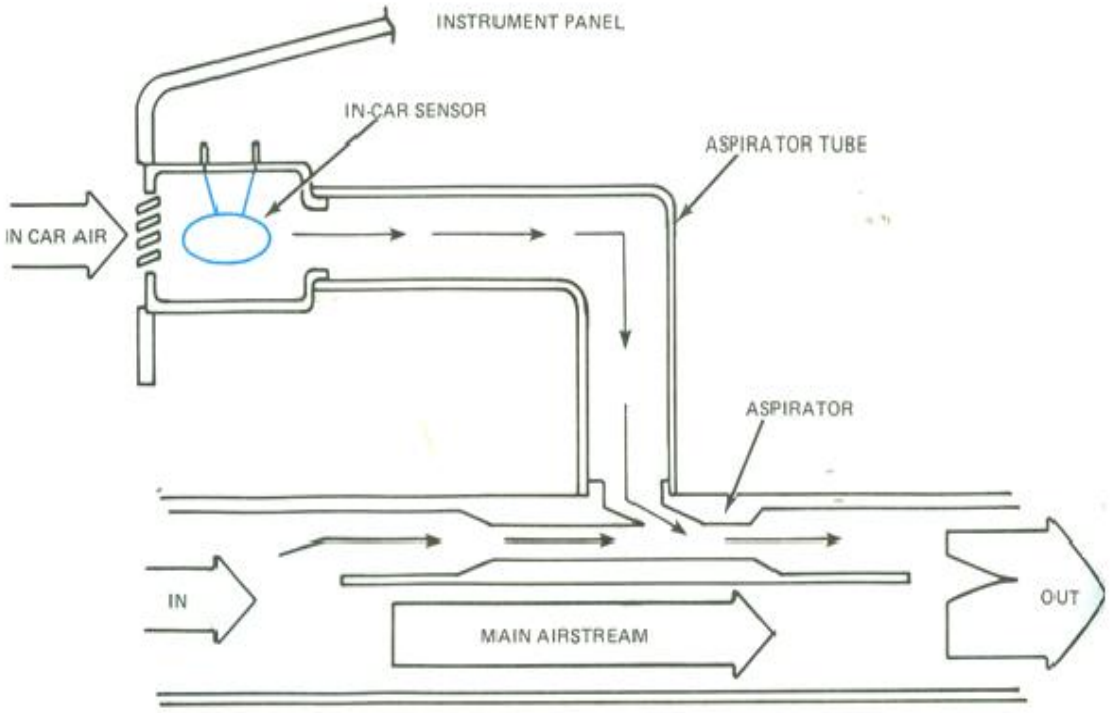


Figure: Concept of Aspirator

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. 2

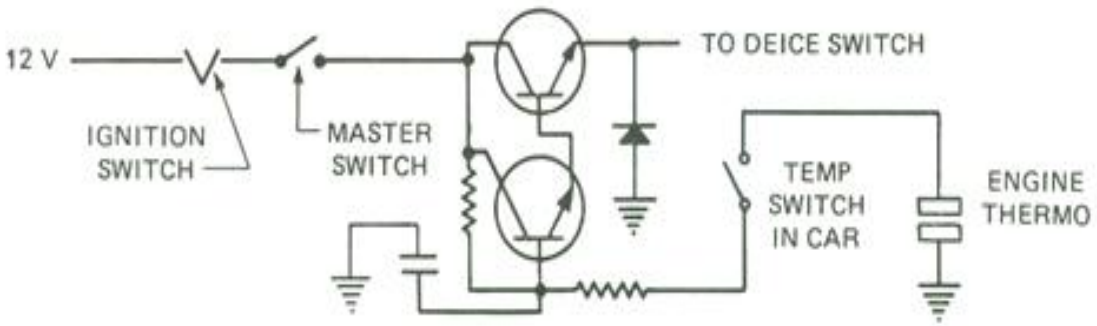
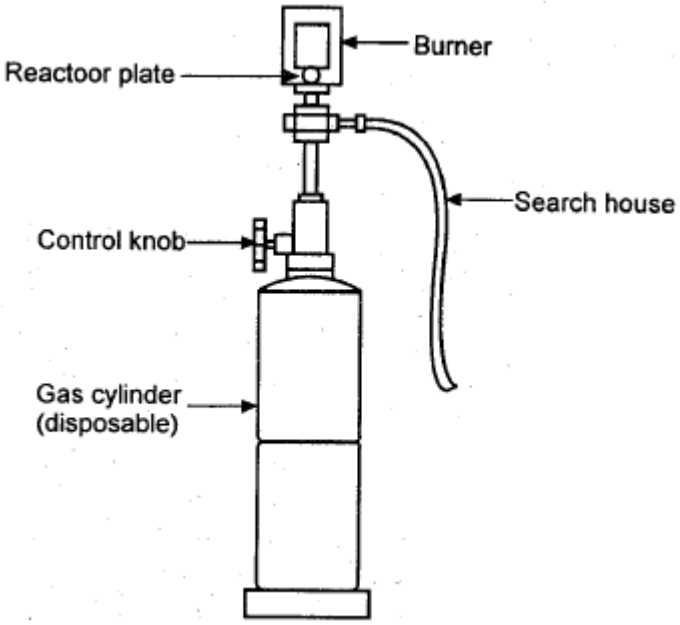
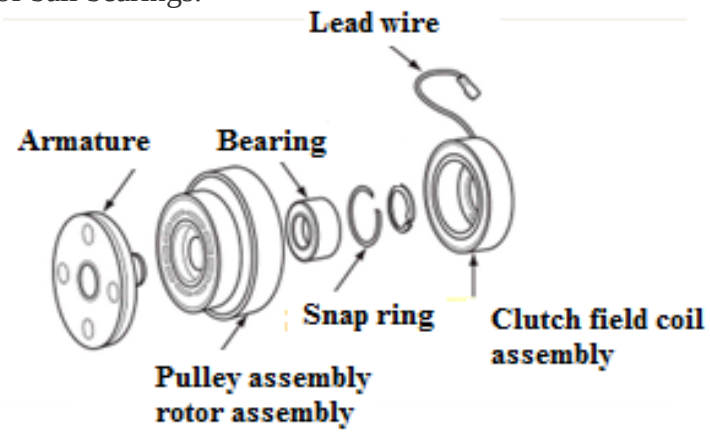
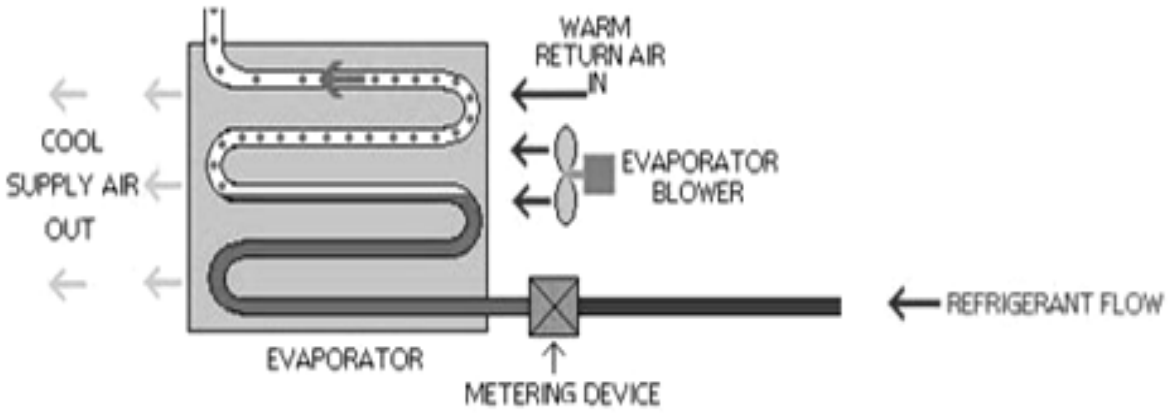
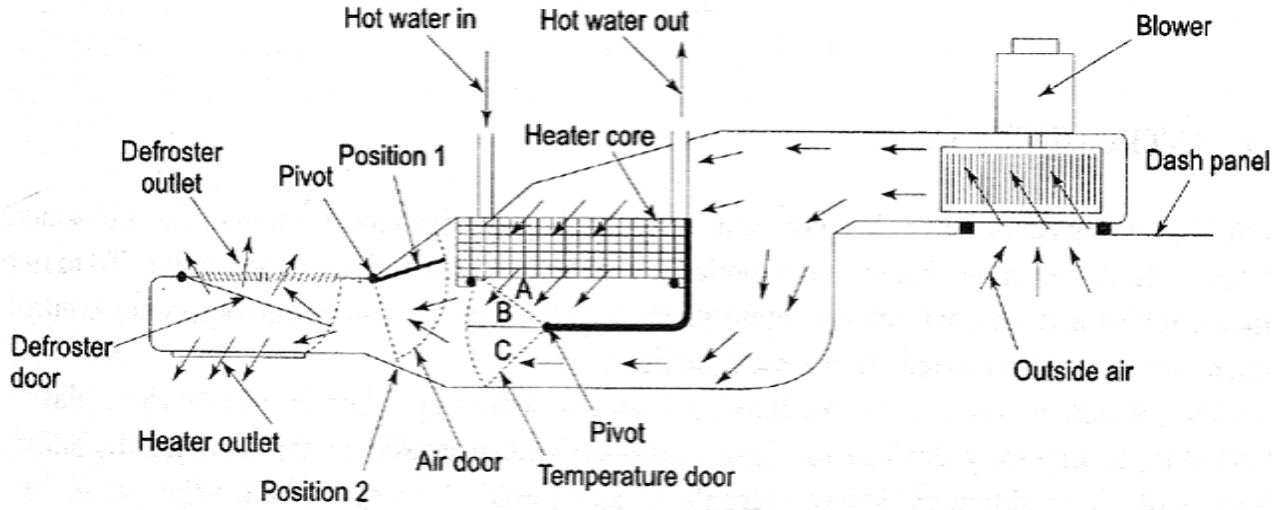


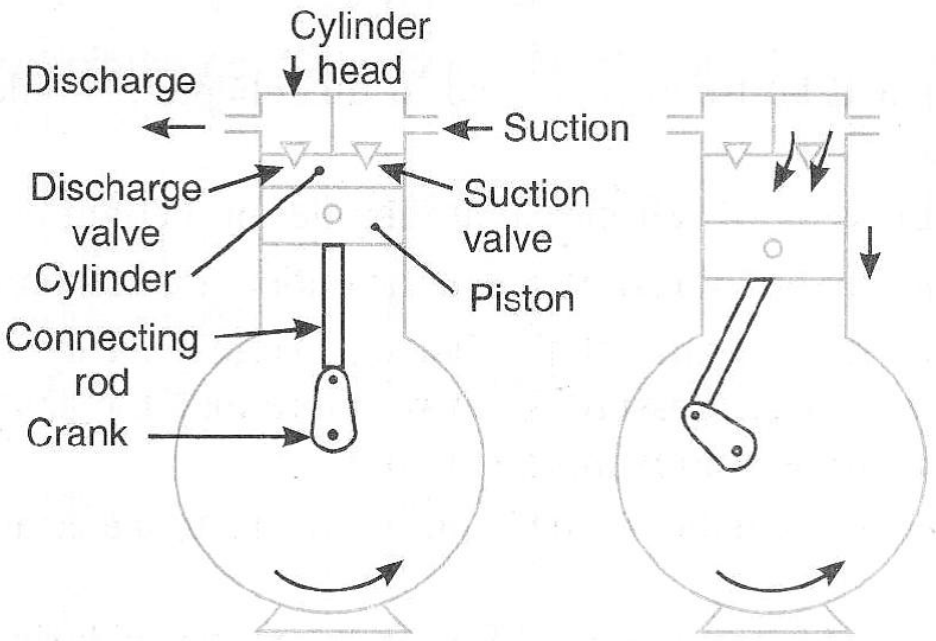
Figure: Time delay relay

d) Explain with neat sketch halide (Freon) leak detector.	4
Answer: Halide (Freon) leak detector: 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.  **Figure: Halide leak detector**	2 2
e) State any four function of comfort heating system.	4
Answer: Functions of comfort heating system: *(Any four)* 1. To provide the desired air temperature inside the passenger compartment. 2. To circulate the hot water from an engine. 3. To heat the air coming from outside atmosphere. 4. To control the temperature by using temperature door. 5. To control the air flow by using air door. 6. To supply heated air on the inside of windshield by using defroster door.	4
f) Explain construction and working of electromagnetic clutch	4
Answer: Construction and working of electromagnetic clutch 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
 **Figure: Assembly of electromagnetic clutch** *Note: Credit shall be given to any other suitable sketch.*	2
3. Attempt any FOUR of the following:	16
a) Describe construction and working of evaporator.	4
Answer: Construction and working of evaporator: **Construction:** The evaporator as shown in figure is the part of refrigeration system where the refrigerant vaporizes as it picks up heat. Heated air is forced through and past the fins and tubes of the evaporator. Heat from the air is picked up by the boiling refrigerant and is carried in the system to the condenser. The evaporator is usually installed in housing under the dash panel.	1
 **Figure: Evaporator**	1

Working: When the air conditioning system is turned on, warm air from the passenger compartment is blown through the coils and fins of the evaporator. The evaporator receives refrigerant from the thermostatic expansion valve or orifice tube as a low pressure, cold atomized liquid. As the cold refrigerant passes through the evaporator coil, heat moves from the warm air into the cooler refrigerant. When the liquid refrigerant receives enough heat, a change of state - from a low pressure liquid into a low Pressure vapor - takes place The thermostatic expansion valve or orifice tube continually meters the precise amount of refrigerant necessary to maintain optimum heat transfer, which ensures that all of the liquid refrigerant will have changed to a vapour by the time it reaches the evaporator outlet. The vaporized refrigerant then continues on to the inlet (suction) side of the compressor.	2
b) State the function and location of i) Sun load sensor ii) Outside temperature sensor	4
Answer: The functions of: **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. **Outside temperature 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
c) State any four properties of refrigerant.	4
Answer: **Properties of refrigerant:** *(Any four properties- 1 mark each)* **Thermodynamic properties:** 1. It should have low boiling point. 2. It should be above atmospheric pressure. 3. It should have high latent heat of vaporization. **Chemical properties:** 1. Toxicity should be low. 2. It should be corrosive. 3. It should not be inflammable. 4. It should be stable in nature. **Physical properties:** 1. It should have low viscosity. 2. It should have high thermal conductivity.	4

Other properties: 1. It should be easy and safe to handle. 2. It should be easily available at low cost.	
d) Explain working of comfort heating system with suitable diagram.	4
Answer: **Working of comfort heating system:** 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. 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	2 2
e) Explain construction and working of reciprocating type compressor.	4
Answer: Construction and working of reciprocating type compressor: Constructional features of reciprocating compressors are as shown in the following figure. It consists of oil sump, crankshaft, piston and ring assembly, valve plate, cylinder head, service valve fitting, reed valve assembly and crankshaft seal assembly etc. **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.	1 2

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.  Figure: Reciprocating type Compressor *(Note: Credit shall be given to any other suitable sketch)*	1
4. a) Attempt any THREE of the following:	12
i) State two environmental and two safety aspects in HVAC system	4
Answer: **Environmental aspects-** 1. To avoid ozone depletion we can replace CFC-12 by HFC-134a. 2. In HVAC system less CO2 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 equipments should not be pressure tested or leak tested with compressed air.	2 2
ii) Give the general layout of Automotive AC system and state function of each component.	4

Answer: General layout of Automotive AC system:

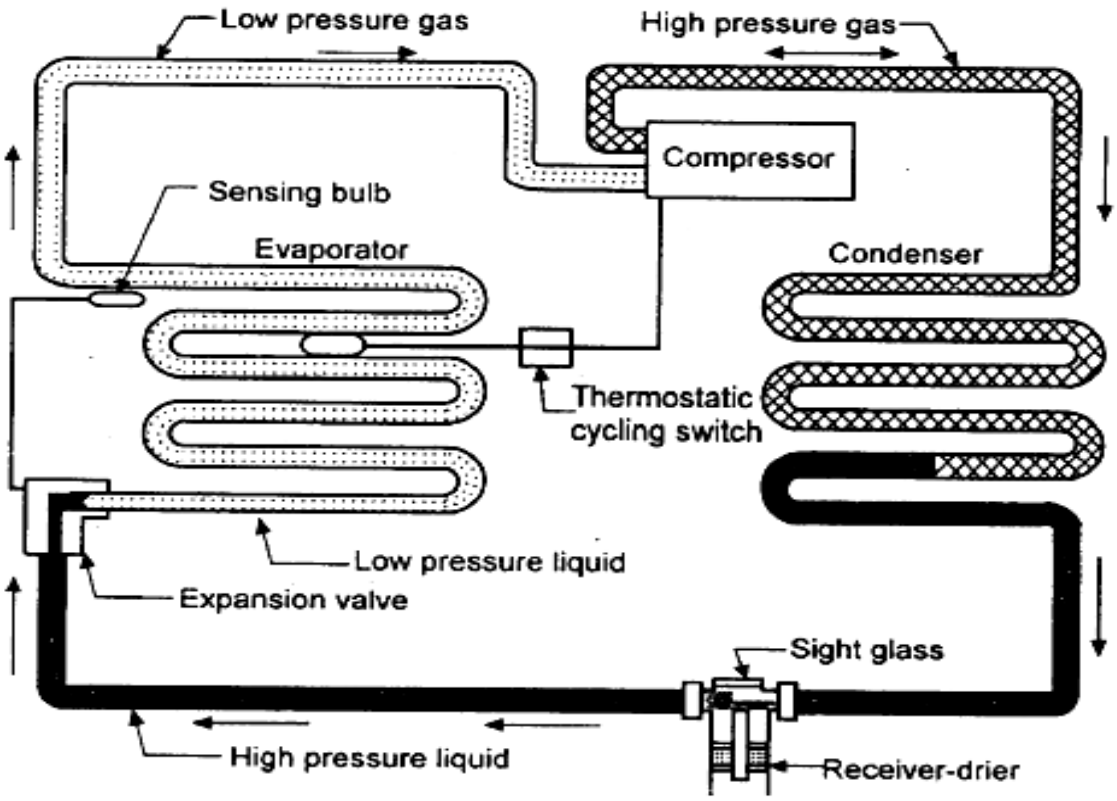


Figure: General layout of automotive A/c System

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

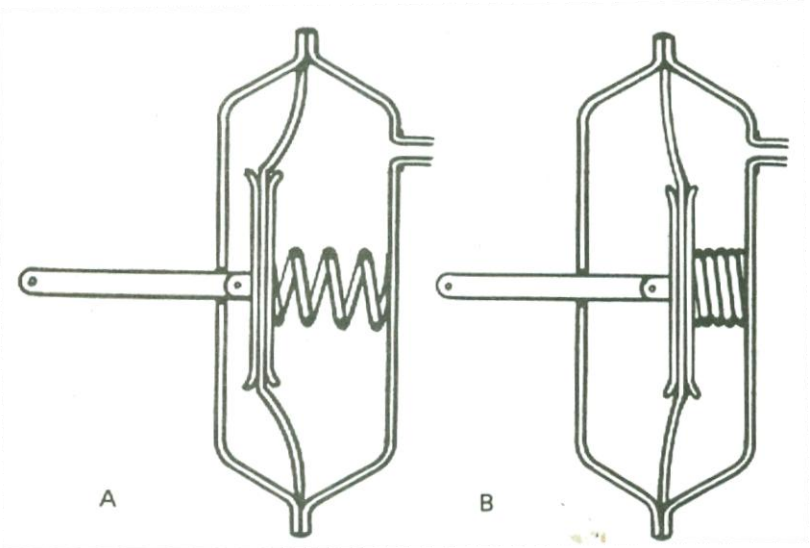
2

iii) Describe the term of modulation and controlling action as a function of thermostatic expansion valve. 4

Answer: Modulation and controlling action as a function of thermostatic expansion valve:

1. **Modulating action:** A thermostatically-controlled valve located inside the expansion valve body fluctuates toward an open or closed position as required to control the liquid refrigerant passing through the orifice. This ensures that the evaporator receives the proper amount of refrigerant. The low pressure created at the expansion valve makes it possible for the liquid refrigerant to vaporize as it passes through the evaporator or coils, absorbing heat from the vehicle's interior.

2

2. Controlling action: The valve must quickly respond to changes in heat load conditions. As increased heat is sensed, the valve will move toward an open position to increase the flow of refrigerant. Decreased heat loads or increased compressor output volume due to increased engine speed will cause the valve to move toward a closed position, restricting the amount of refrigerant entering the evaporator	2
iv) Explain construction and working of vacuum motor with neat sketch.	4
Answer: Construction and working of vacuum motor:  **Figure: 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.	2 2 2
b) Attempt any ONE of the following:	6
i) Explain with neat sketch rear heating system	6
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 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.	3

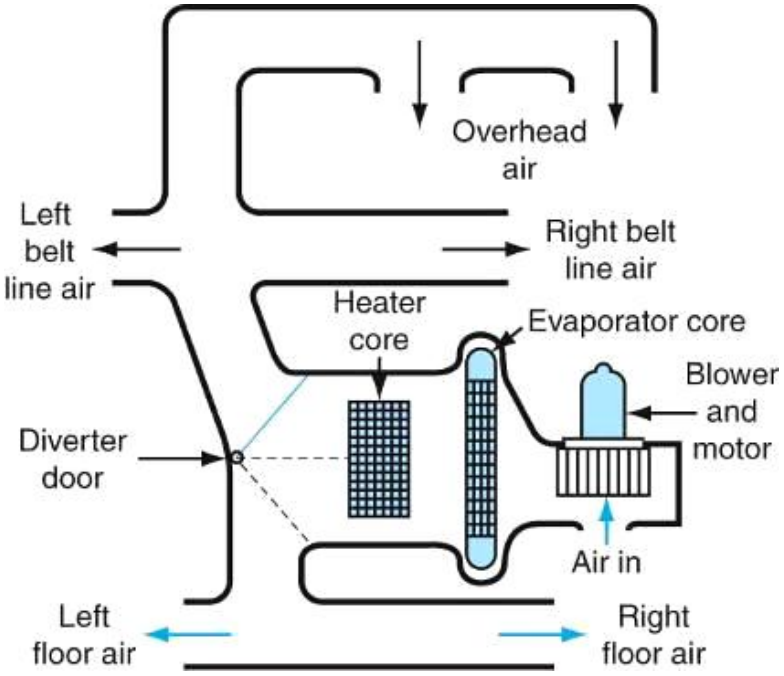
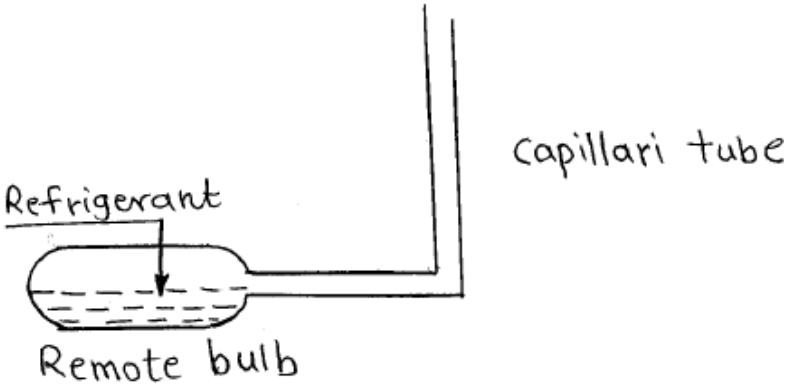


Figure: Rear heating system — 3

ii) Describe construction and working of remote bulb. — 6

Answer: Construction and working of remote bulb:

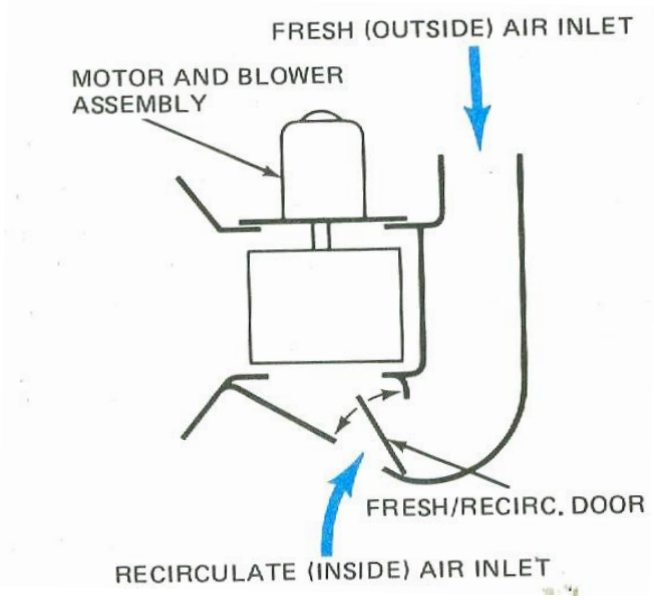
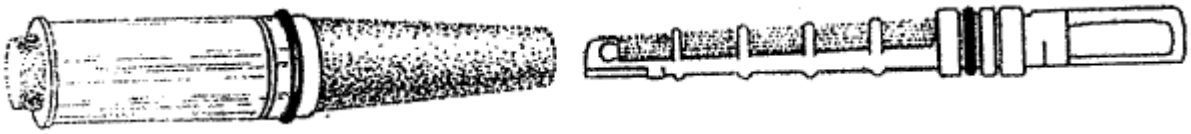
Construction: Figure shows remote bulb. One end of capillary tube is connected to remote bulb and other end is connected to thermostatic expansion valve. A remote bulb filled with refrigerant same like refrigerant in A/C system. It is located at evaporator outlet. It maintains pressure on diaphragm against evaporator pressure and spring pressure. — 2

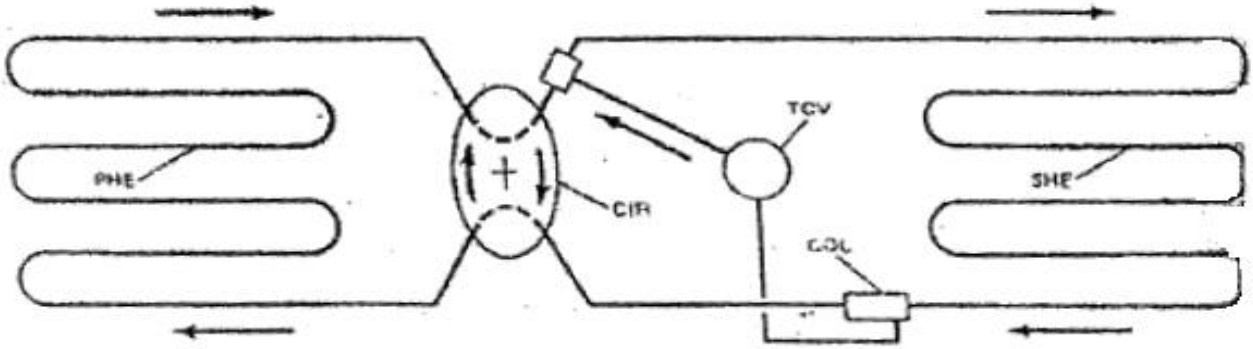
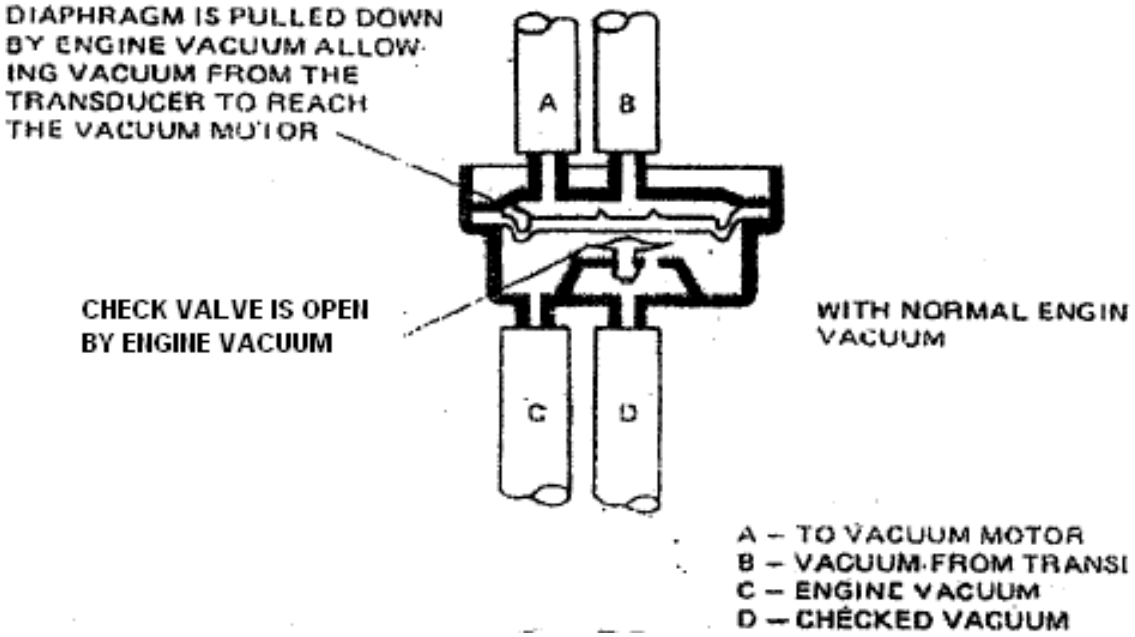


— 2

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. — 2

5. Attempt any FOUR of the following:	16
a) Explain working of air intake section with neat sketch.	4
Answer: Working of air intake section :  **Figure: 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. Actually in all modes except maximum cooling, the air supply is from outside. In maximum cooling, the air supply is from inside. Even in the maximum cooling mode, some systems provide for up to 20% fresh air. This is to provide for a slightly positive in-car pressure.	2 2
b) Explain construction and working of fixed orifice tube.	4
Answer: Construction and working of fixed orifice tube: **Construction:** Fixed orifice tube has no moving parts. Tube is not adjustable and its failure is usually a result of becoming clogged. Cleaning of clogged orifice tube is very difficult. After clogged orifice tube is necessary.  Figure: Old and new style fixed orifice tube **Working:** The refrigerant entering into the evaporator is controlled by the fixed orifice tube in manner which is based on pressure difference and sub cooling characteristics of the refrigerant. Fixed orifice tube replaces thermostatic expansion valve to meter refrigerant into the evaporator The old and new expansion tubes as shown in figure are not interchangeable.	2 2

c) Explain working of rotary vane air cycle system with neat sketch.	4
Answer: 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
d) Explain the constructions and working of check valve.	4
Answer: Construction and Working of Check valve:  Figure: Check valve	1

Construction: 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

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. — 2

e) State cause of fault and remedy of compressor (any four) — 4

Answer: ***(Any four)*** — 4

Fault	**Causes**	**Remedies**
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
Compressor not working	Broken belt	Replace belt
	Broken clutch wire	Repair wire
	Bad thermostat	Repair thermostat
	Bad clutch coil	Repair
Low Compressor discharge pressure	Leakage system	Repair leakage
	Defective expansion valve	Repair valve
	Suction valve closed	Open it
High compressor discharge pressure	Air in system	Recharge system
	Clogged condenser	Clean condenser
	Discharge valve closed	Open valve
Low suction pressure	Refrigerant shortage	Add refrigerant
	Worn compressor piston	Replace compressor
	Compressor suction valve leaking	Change valve
High suction pressure	Loose expansion valve	Tighten valve
	Overcharged system	Remove some refrigerant
	Expansion valve stack open	Replace expansion valve

f) How do you carry out leak test and temperature test of AC system. — 4

Answer: Leak test and temperature test of AC system:

Procedure to carry out leak test and temp test- — 2

1. Install the gauges and gauge manifold. Note the pressure and the temperature in the beginning.
2. Close the manifold valves.
3. Now, attach the refrigerant cylinder at the center of the gauge manifold. Do not open the refrigerant cylinder valves. Do not operate the compressor.
4. Start halide leak detector.
5. Now open the refrigerant cylinder valve.

6. Now open the gauge manifold valves slowly. Raising the pressure to about 1.75kgf/cm^2.
7. Check the leaks with torch. Any leak detected should be repaired properly.
8. Raise the system pressure to about 3.75kg/cm2 and check leaks at various joints and surfaces. Repair the leakage.
9. Now Raise the pressure about 5.0kgf/cm2 in the gauges and check the leaks.
10. Close refrigerant cylinder valve after completing the job, close gauge manifold valves

Procedure to carry out temp test-

1. Connect manifold gauge set at high and low side valves.
2. Turn on engine and allow temperature to reach 210C or high. 2
3. Take tachometer and run engine at 1500rpm.
4. Turn on AC for 5min and close all windows and doors.
5. Before that place thermometer at the centre outlet of AC panel.
6. Compare readings as per specifications.

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

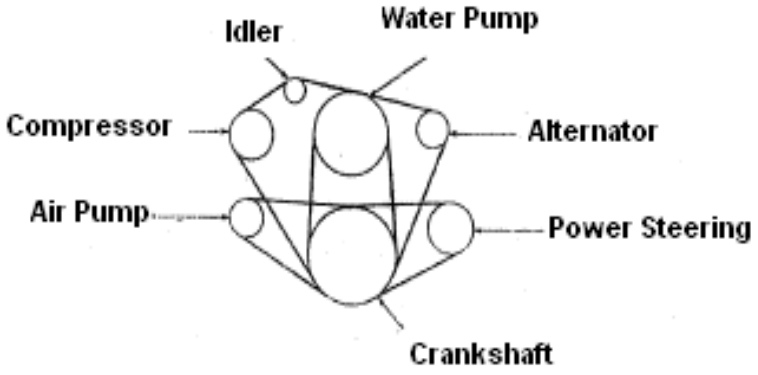
6 Attempt any FOUR of the following 16

a) Explain the drive system for compressor in automobile air conditioning 4

Answer: 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 belt tension. 2



2

Figure: Compressor driven off crankshaft pulley by one or two belts

OR

2. **Compressor driven off crankshaft by single 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.

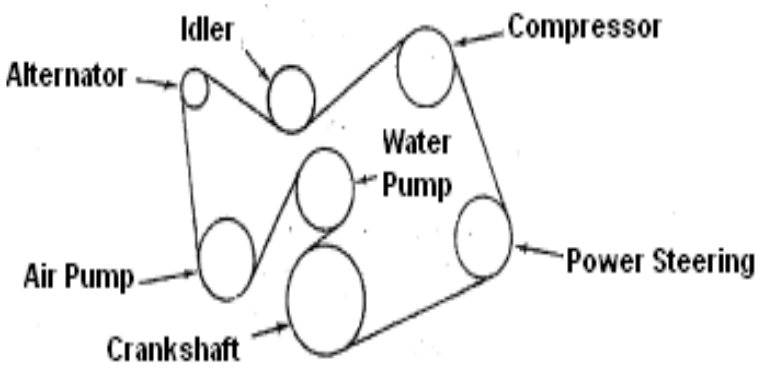


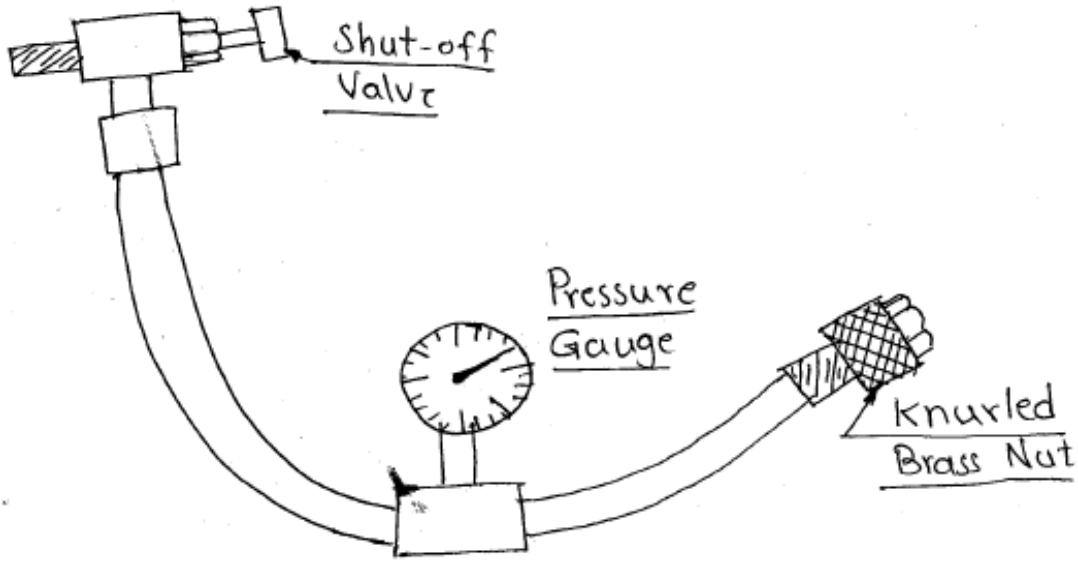
Figure: Compressor driven off crankshaft by Serpentine belt:

b) Discuss the construction of charging hose with shutoff valve. 4

Answer: Construction of charging hose with shutoff valve:

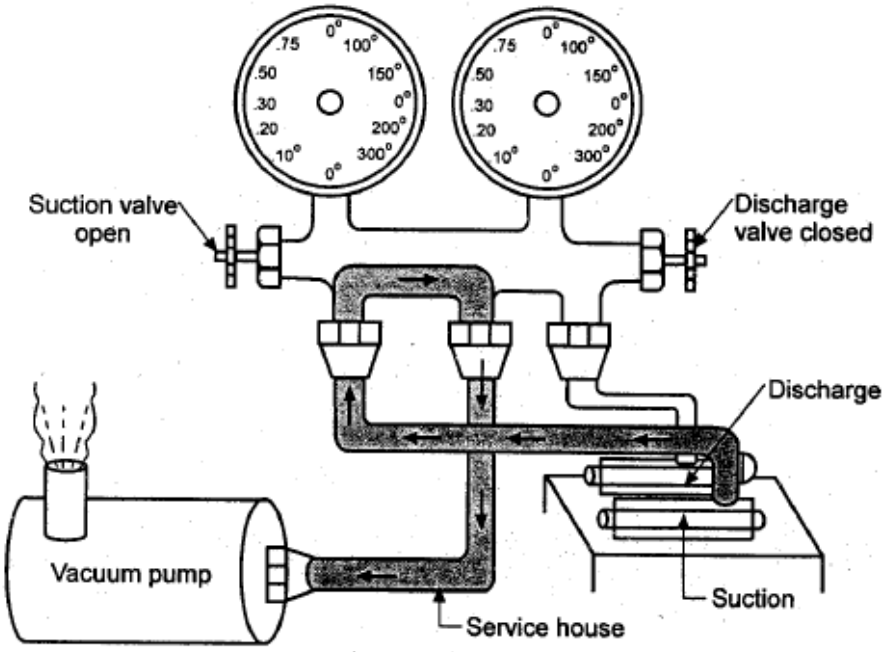
Features of charging hoses include: 2

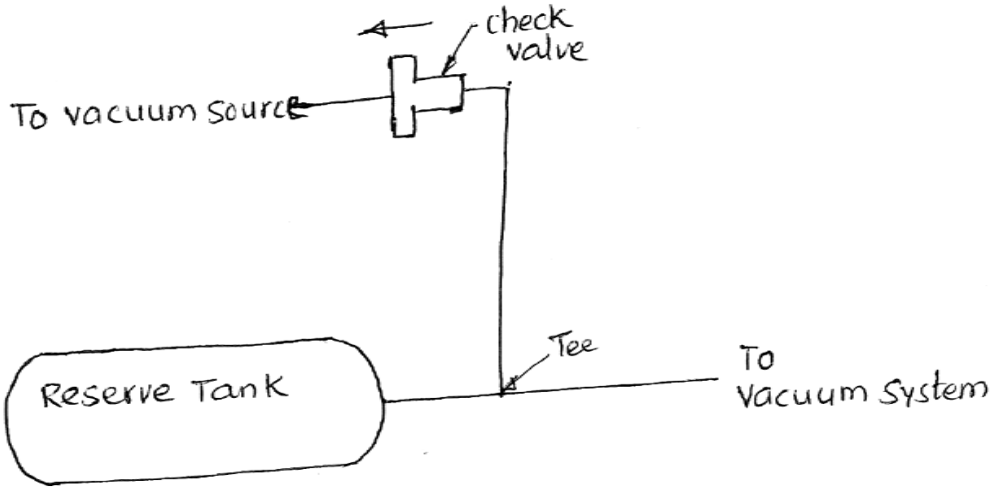
- Standard 870 psi working pressure, 3600 psi burst pressure making the charging hoses good for all refrigerants including R410A
- Eight sided crimp ensures maximum hose life
- Knurled brass nut for easy finger tightening
- Multiple lengths available
- Color coded for convenience
- Available in packs of 3 (one red, one yellow and one blue hose) or individually



2

Figure: Charging hose with shutoff valve

c) Explain the working of typical vacuum system with neat sketch.	4
Answer: 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.  Figure: Typical Vacuum system. 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 charging hose ⟶ Compressor delivery hose. Low charging 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.	2 2
d) Explain the 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. 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 rturns 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.	4
e) Explain the construction and working of vacuum reserve tank with neat sketch.	4
Answer: 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	3 1