Scoring Indicators

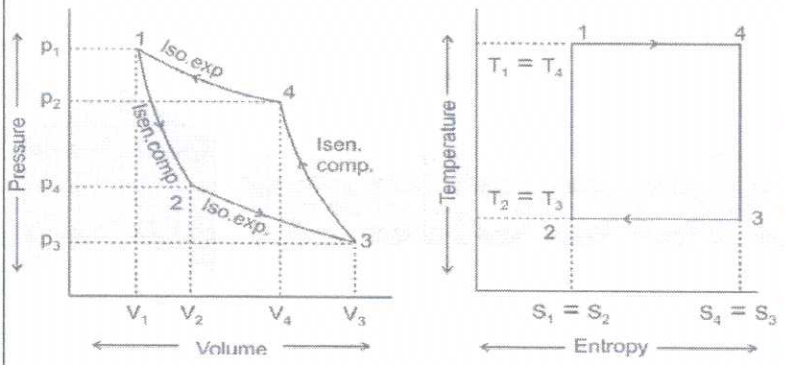
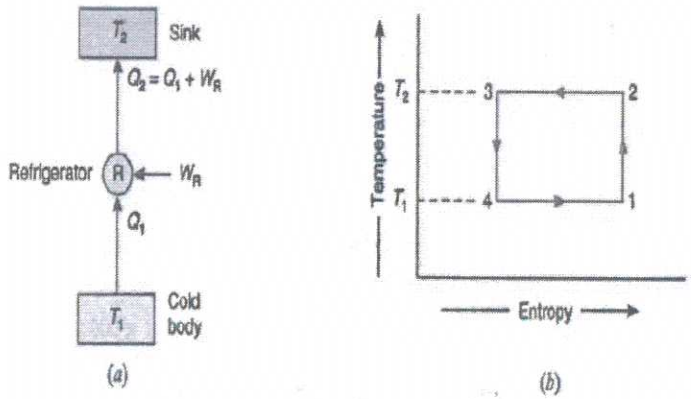
COURSE NAME: REFRIGERATION AND AIR-CONDITIONING

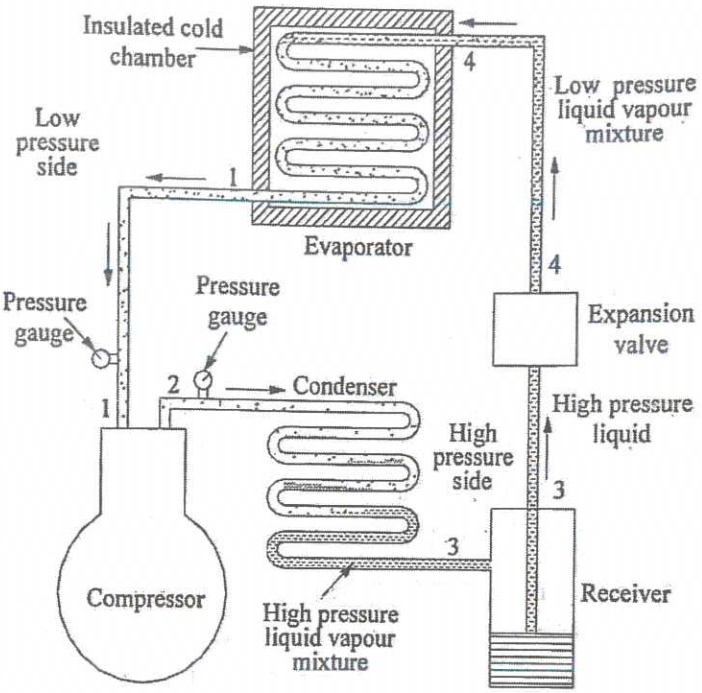
COURSE CODE: 5022 **QID : 2109230035**

Q No	Scoring Indicators	Split score	Sub Total	Total score
	PART A			**9**
I. 1	Gas liquefaction	1	1	
I. 2	Refrigeration is a process of achieving and maintaining a low temperature below that of surroundings.	1	1	
I. 3	Always more than unity	1	1	
I. 4	Expansion valve	1	1	
I. 5	Discharge pressure	1	1	
I. 6	window air conditioners, water coolers and packaged air conditioning plants	Any one	1	
I. 7	Increases	1	1	
I. 8	Dry bulb temperature	1	1	
I. 9	Heated and humidified	1	1	
	PART B			24
II. 1	➢ Air is easily available ➢ It is cheap ➢ Weight per TR is low and hence ideal for aircraft refrigeration ➢ No leakage problem ➢ It is non-flammable and non-toxic refrigerant ➢ Low maintenance cost	Any Three	3	
II. 2	Primary refrigerant directly take part in refrigeration, Eg Freon (R11, R22, R32, R407C, R134a etc), Ammonia, water. Theses refrigerants directly absorb heat from a system and take part of refrigerant cycle. In case of Primary refrigerant latent heat transfer takes place.	Explanation 3	3	

II. 3	1. Improvement by adding Flash Chamber. 2. Improvement by adding Accumulator. 3. Improvement by Subcooling of liquid refrigerant by using vapours of refrigerant. 4. Improvement by Subcooling of liquid refrigerant by using Liquid refrigerant.	1 x 3	3	
II. 4	1. Visual Inspection 2. Bubble Water or Soapy Water Detection 3. Nitrogen Water Detection 4. Fluorescent Leak Detection 5. Gas Pressure Detection	Any three 1 x 3	3	
II. 5	Cryogenics has numerous applications in space science, electronics, automobiles, the manufacturing industry, sports and musical instruments, biological science and agriculture, etc.	1 x 3	3	
II. 6	1. According to the method of compressor ➢ Reciprocating compressors ➢ Rotary compressors ➢ Centrifugal compressor 2. According to the number of working strokes ➢ Single acting compressor ➢ Double acting compressors 3. According to the number of stages ➢ Single stage compressors ➢ Multi stage compressor	Explanation 3	3	

II. 7	***Dry bulb temperature***. It is the temperature of air recorded by a thermometer, when it is not affected by the moisture present in the air. ***Wet bulb temperature***. It is the temperature of air recorded by a thermometer, when its bulb is surrounded by a wet cloth exposed to the air. **Dew point temperature**. It is the temperature of air recorded by a thermometer, when the moisture (water vapour) present in it begins to condense.	1x 3	3	
II. 8	According to Dalton's law of partial pressures, the total pressure by a mixture of gases is equal to the sum of the partial pressures of each of the constituent gases. The partial pressure is defined as the pressure each gas would exert if it alone occupied the volume of the mixture at the same temperature.	Explanation 3	3	
II.9	HVAC is an acronym that stands for Heating, Ventilation, and Air Conditioning. The term HVAC is used to describe a complete home comfort system that can be used to heat and cool your home, as well as provide improved indoor air quality.	Explanation 3	3	
II.10	1. Effective temperature, 2. Heat production and regulation in human body, 3. Heat and moisture losses from the human body, 4. Moisture content of air, 5. Quality and quantity of air. 6. Air motion, 7. Hot and cold surfaces, and 8. Air stratification.	Explanation 3	3	

	PART C			42
III.	In a Carnot cycle, the working substance is subjected to a cyclic operation consisting of two isothermal and two adiabatic processes. The engine developed by Carnot has air (which is assumed to work as a perfect gas) as its working substance enclosed in a cylinder, in which a frictionless piston moves.  	Fig 3 Explanation 4	7	7
IV	The refrigeration cycle working on Carnot cycle is shown in Fig 2.6. Since 1.5 kW per tonne of refrigeration is required to maintain the temperature in the refrigerator, therefore amount of work required to be done, $W_R = 1.5\ \text{kW} = 1.5\ \text{kJ/s} = 1.5 \times 60 = 90\ \text{kJ/min}$ and heat extracted from the cold body, $Q_1 = 1\ \text{TR} = 210\ \text{kJ/min}$ We know that $(\text{C.O.P.})_R = \frac{Q_1}{W_R} = \frac{210}{90} = 2.33$ Ans.  	2 3 2	7	7

Q. 8 V	Vapour compression refrigeration cycle Vapour compression refrigeration cycle consist of four different processes 1) Compression 2) Condensation 3) Expansion 4) Evaporation Components and its functions 1) Compressor – The low pressure & temperature refrigerant from evaporator is drawn into compressor. It is compressed to a high pressure & high temp. vapour refrigerant is discharged into condenser. 2) Condenser – High pressure & temperature vapour refrigerant is cooled and condensed by using air or water & form liquid vapour refrigerant. Heat is rejected 3) Expansion valve – to control flow of refrigerant and reducing it pressure and temperature 4) Evaporator – liquid vapour refrigerant at low pressure and low temperature is evaporated by absorbing heat from system or substance and change into vapour refrigerant.  	Fig 3 Explanation 4	7	7

12.a VI	1. Low Boiling Point 2. Low Condensing Pressure 3. High Specific Enthalpy of vaporization 4. High Critical Temperature. 5. Low Specific Volume 6. Non-Corrosive **and** Stable 7. Non-flammable and Non-explosive 8. Easy leak detection possible 9. Non-Toxic 10. Cheap and Easily available.	Any 7	7	7
12.b VII	**Advantages of cryogenic refrigeration** ➢ Eco friendly. ➢ Rapid freezing. ➢ Inhibition of bacterial growth. ➢ Limited dehydration. ➢ Has higher mass flow rate than fossil fuels. ➢ produce more thrust. **Application** ➢ Cryosurgery ➢ Cryoelectronic Cooling ➢ Cryobiology ➢ Food Preservation ➢ Transportation of Gases ➢ Cryotherapy	4 3	7	7

VIII

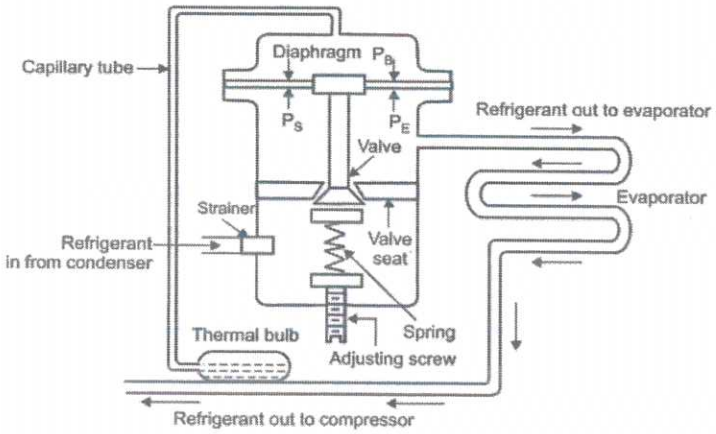


Fig. 1: Thermostatic expansion valve.

A thermostatic expansion valve (TXV) is a refrigeration and air conditioning throttling device that controls the amount of refrigerant liquid injected into a system's evaporator—based on the evaporator outlet temperature and pressure—called the superheat. Figure 2 shows the different phases and pressures the refrigerant goes through as it is pumped through the system, moving through the evaporator, the compressor, the condenser, and the throttling device which injects liquid refrigerant into the evaporator before it moves into the compressor.

Fig 3 Explanation 4	7	7

IX

A Water-Cooled Condenser is a heat exchanger that removes heat from refrigerant vapour and transfers it to the water running through it. Having the refrigerant vapour condensed on the outside of a tube achieves this. In doing so, the vapour condenses and gives up heat to the water running inside the tube.

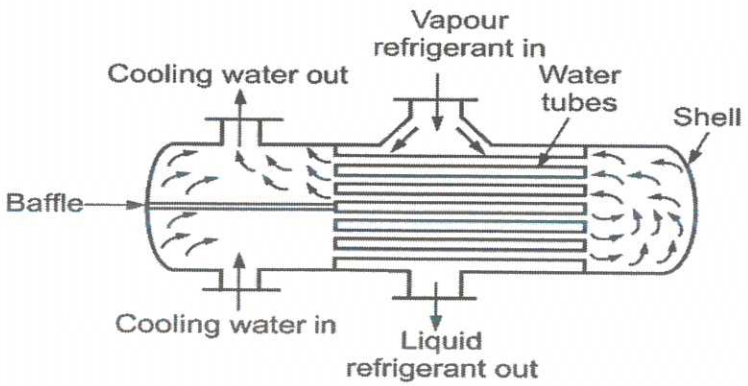
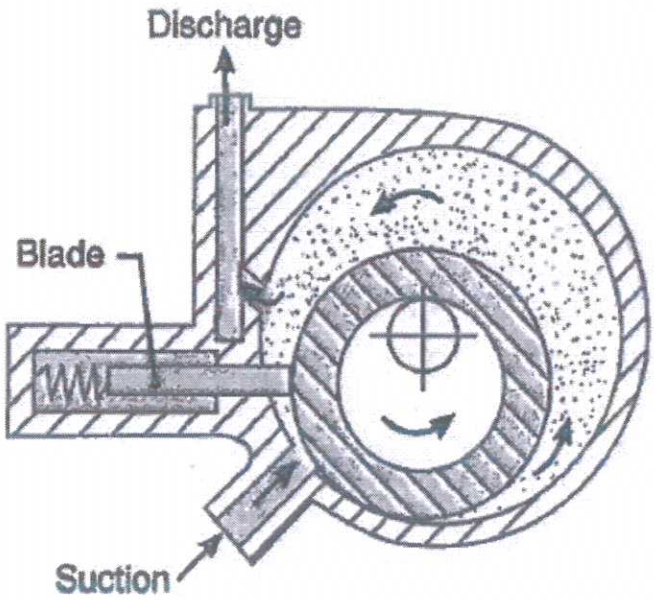
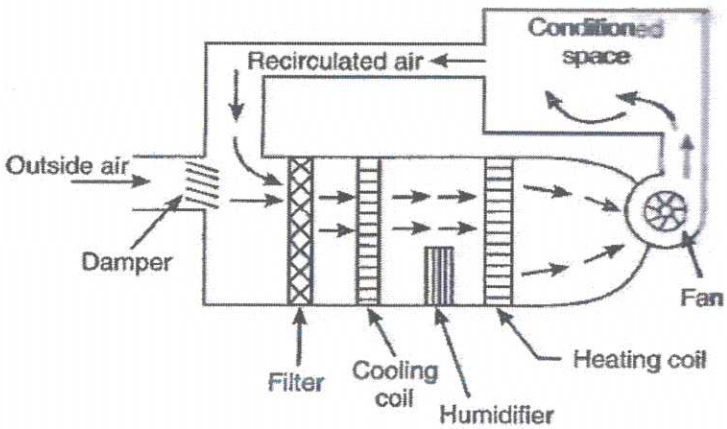


Fig 3 Explanation 4	7	7

X	An opening valve sucks gas into the compressor chamber. Located in the chamber are the two screw rotors; when the machine is on, they will rotate at high speeds. As the impellers rotate, they trap and isolate air in the cavities between the rotors, thus moving the air down the chamber.  	Fig 3 Explanation 4	7	7
XI	**Summer Air conditioning system** / **Winter Air conditioning system** Used in summer, when air is to be cooled. / Used in winter, when air is to be heated. Refrigerating circuit (cooling coil) is used. / Refrigerating circuit need not be used. Cooling of air may be accompanied by either dehumidification or humidification. / Heating of air is accompanied by humidification. Water eliminator is not required. / Water eliminator is required. One heating coil is used to control the temperature of air as per comfort level. / Two heating coils are used to control the temperature of air as per comfort level. Low operating cost. / High operating cost. Used in hot regions like INDIA, Gulf, Australia, Africa. / Used in cool regions like Europe, Russia, Japan etc.	Any 7	7	7

XII	**Solution** DBT = 42^0C $\therefore p_s = 8.20$ kPa WBT = 30^0C $\therefore p_w = 4.246$ kPa $p_v = p_w - \frac{(p - p_w)(T_{db} - T_{wb})(1.8)}{2800 - 1.3(1.8T_{db} + 32)}$ $= 4.246 - \frac{(101.325 - 4.246)(42 - 30)(1.8)}{2800 - 1.3(1.8x42 + 32)} = 3.467\,kPa$ ***Humidity ratio*** $w = 0.622\frac{p_v}{p - p_v}$ $= 0.622\frac{3.467}{(101.325 - 3.467)}$ $= 0.02204$ kg/kg dry air ***Relative humidity*** $RH = \frac{p_v}{p_s} x100 = \frac{3.467}{8.20} x100 = 42.28\%$	3 2 2	7	7
XIII	In year-round air conditioning system, the outside air flows through the damper and mixed with the recirculated air (which is obtained from the conditioned space). The mixed air passes through a filter to remove dirt, dust and impurities. In summer air conditioning, the cooling coil operates to cool the air to the desired value. The dehumidification is obtained by operating the cooling coil at a lower temperature than the dew point temperature (apparatus dew point). In winter, the cooling coil is made inoperative and the heating coil operates to heat the air.  	Fig 3 Explanation 4	7	7

~~III-12~~

XIV

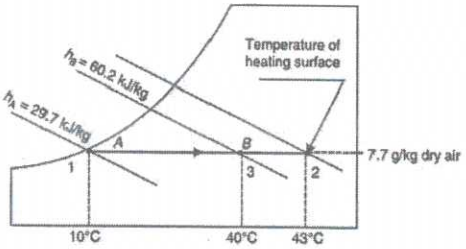
Psychrometric chart

The point A is located on the saturation curve at 10°C (See following figure)

$w_A = 7.7$ g/kg dry air

$h_A = 29.7$ kJ/kg dry air

$v_a = 0.812$ m^3/kg dry air



3

Locate state B

$h_B = 60.2$ kJ/kg dry air

$w_b = w_A = 7.7$ g/kg dry air

7 | 7

WBT of air

WBT at state A = 10°C

WBT at state B = 20.2°C

2

Sensible heat transfer rate

Mass flow rate of air

$m_A = 5000/(0.812 \times 3600) = 1.71$ kg/s

Sensible heat transfer rate 2

$= m_A(h_B - h_A)$

$= (1.71)(60.2 - 29.7)$

$= 52.17$ kW