MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

Summer-13 EXAMINATION

Model Answer

Subject & code:PUT (12129)

Important instructions to examiners :

1. The answers should be examined by keywords 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 given more importance.
4. While assessing figures, examiner may give credit for principal components indicated in a 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 answer and model answer.
6. In case of some questions credit may be given by judgment of relevant answer based on candidates understanding.

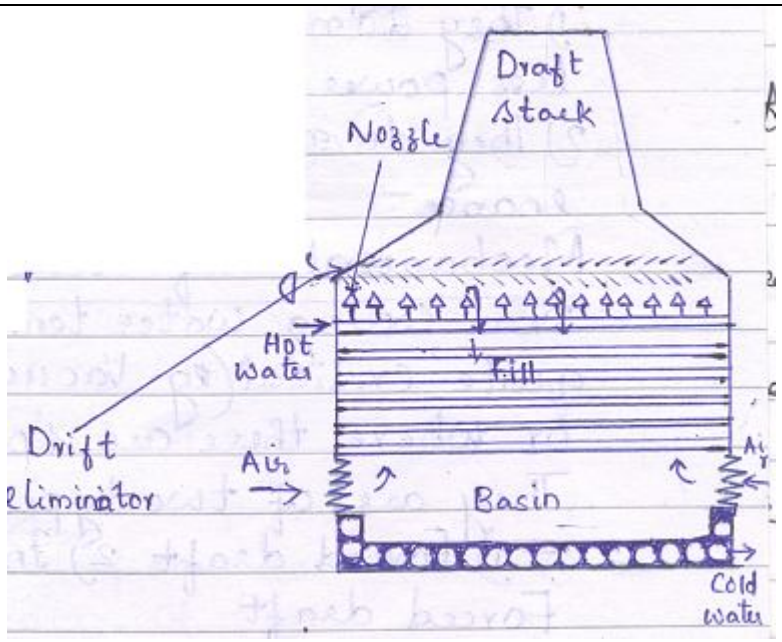
<table>
<tr><th>Q no:</th><th>Answer</th><th>mark</th><th>Total marks</th></tr>
<tr><td>1a. i</td><td>Different sources of water are:
1. Surface water
a. Rain water
b. River water
c. Lake water
d. Sea water
2. Underground water</td><td>1

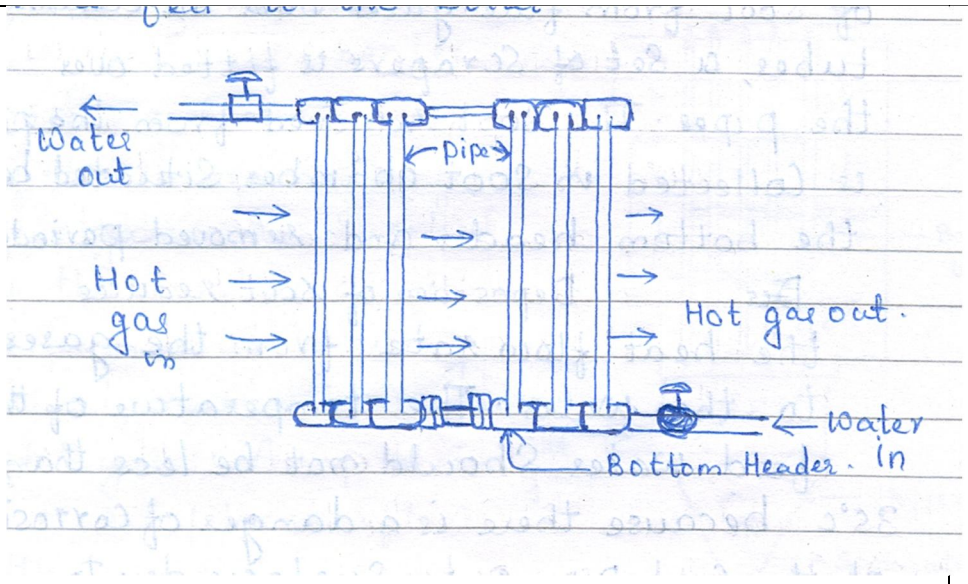
1</td><td>2</td></tr>
<tr><td>ii.</td><td>
<table>
<tr><th>Hard water</th><th>Soft water</th></tr>
<tr><td>Contains dissolved salts of calcium and magnesium</td><td>Does not contain dissolved salts of calcium and magnesium</td></tr>
<tr><td>Does not produce lather or foam</td><td>produces lather or foam with</td></tr>
</table>
</td><td>1

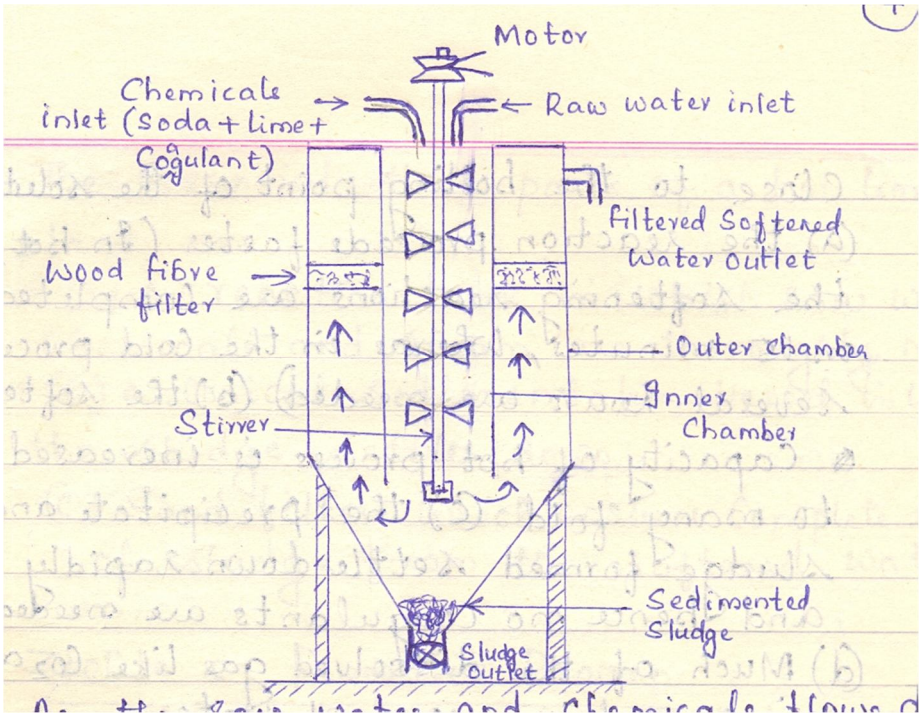
1</td><td>2</td></tr>
</table>

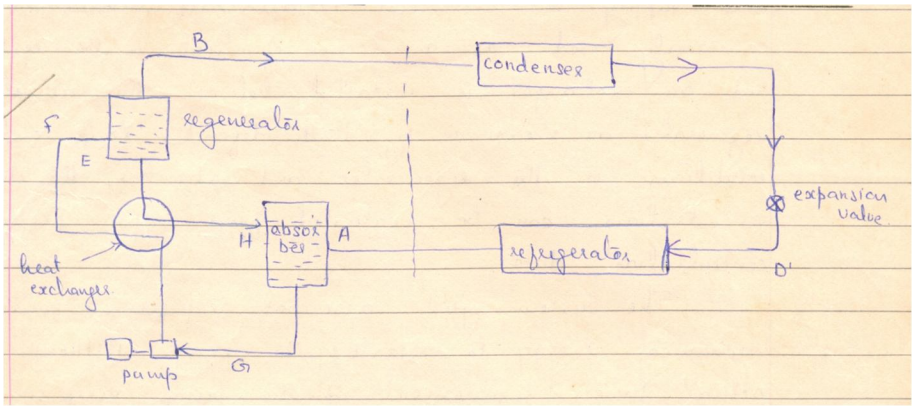
	with soap | soap		
iii.	**Basic principle of refrigeration:** Refrigeration is maintaining a temperature lower than the surrounding temperature by using proper refrigerant.	2	2
iv	**Wet bulb temperature:** It is the temperature indicated by a thermometer whose bulb is covered with a wetted cotton	2	2
v	**Uses of compressed air:** 1. In chemical process 2. In automatic controllers to control the process	 1 1	2
vi	**Carbonate and bicarbonate hardness:** It is the hardness developed in water due to the presence of dissolved bicarbonates of of calcium and magnesium. It is destroyed by boiling of water. heat $Ca(HCO_3)_2$ -----→ $CaCO_3 + H_2O + CO_2$ heat $Mg(HCO_3)_2$ -----→ $Mg(OH)_2 + 2\ CO_2$	2	2
vii	**Desired properties of insulators:** 1. It should have sufficient resistance to vibration and shock 2. It should be odorless 3. It should be cheap 4. It should be fire proof 5. It should resist moisture absorption 6. It should have low density 7. It should be strong enough to bear the load applied on it.	½ mark each for any four	2
viii	**Types of steam generators:**		2

	1. Based on tube content a. Water tube boiler b. Fire tube boiler 2. Based on position of funace a. Internally fired boiler b. Externally fired boiler ***Any other classification may be considered.***	1 1	
1 b i	Boiler is inspected before the certificate for its operation is given to its employer. Before inspecting the boiler 1. It is cleaned 2. All fittings such as burners etc are removed 3. Valves and cocks are opened.	4	4
1.b.ii	**Natural draft cooling tower:** The atmospheric towers depend on prevailing wind for air movement. The natural draft design ensures more positive air movement even in calm weather by depending upon the displacement of the warm air inside the tower by the cooler outside air. Fairly tall chimneys are ten required. The tower must be relatively tall in order to operate at a small wet bulb temperature approach. Natural draft equipment is used where the humidity is usually low, air temperatures are generally low, with increasing frequency everywhere as energy for fan power becomes more costly.	4	4

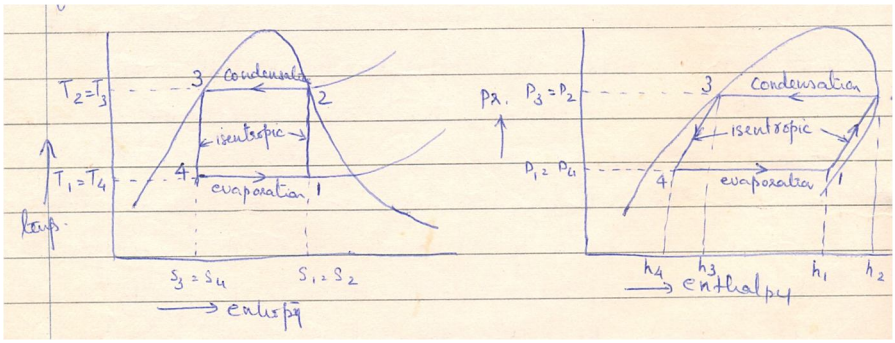
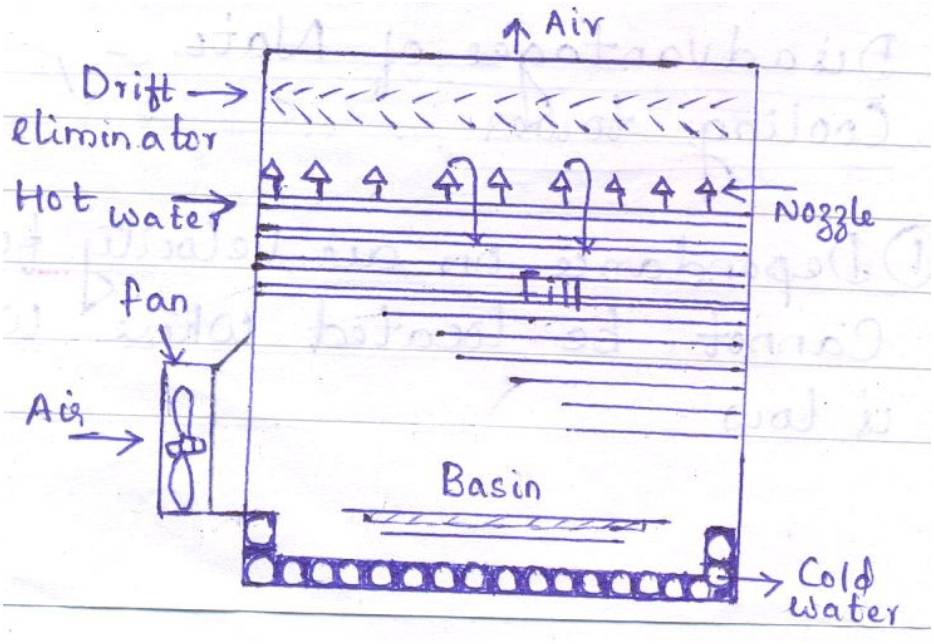
			
1.b. iii	**Economiser** **Construction**: It consists of groups of vertical cast iron pipe. The tubes are fitted at their two ends to the cast iron boxes , at the top and the bottom. These are pressed hydraulically into the top and bottom boxes. The sides of the top boxes are machined and bolted together to form an air tight roof. All the tubes are enclosed within the brickwork of the economizer. There are two pipes outside the brickwork. **Working:** Economizer is used to recover some of the heat from the heat carried away in the flue gases up the chimney and utilize for heating the feed water to the reboiler. From the water inlet water goes to the bottom boxes and rises up in the vertical pipes into the top boxws. From the top boxes it goes to the pipe from where it goes to the water space of the boiler via check valve.	2 2	4

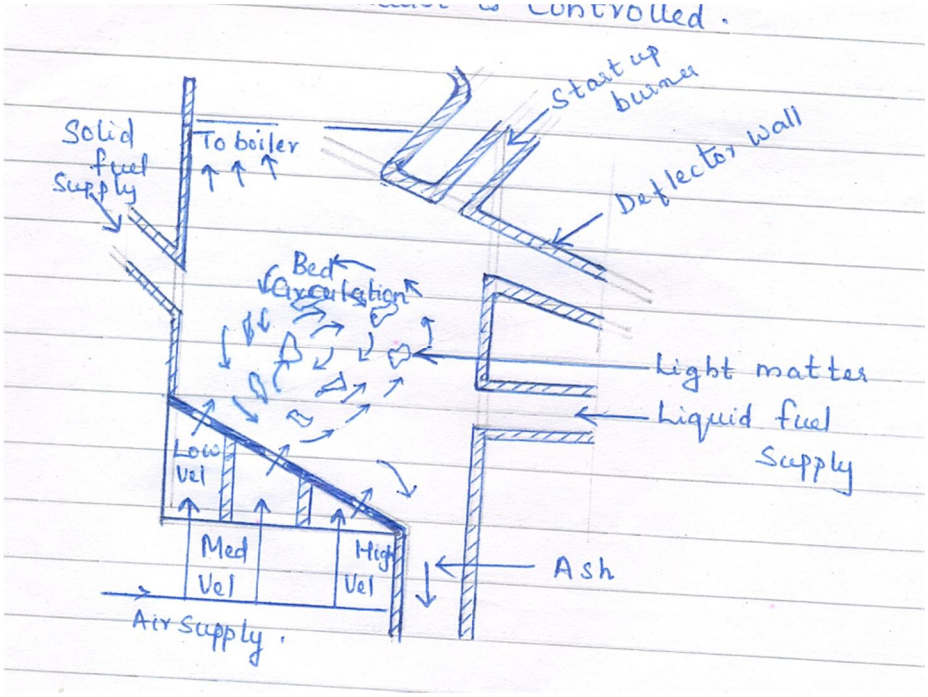
			
2a	**Lime soda method:** In lime soda process, hard water is treated with calculated quantities of slaked lime [$Ca(OH)_2$] and soda ash [Na_2CO_3]. The reactions are: $2HCl+Ca(OH)_2$ ---------→$CaCl_2 + 2\ H_2O$. $CaHCO_3 + Ca(OH)_2$ ---------→$2\ CaCO_3 + 2\ H_2O$. $MgCl_2 + Ca(OH)_2$ ---------→ $Mg(OH)_2 + CaCl_2$ $Ca(OH)_2 + CO_2$---------→ $CaCO_3 + H_2O$. $CaCl_2 + Na_2CO_3$ ---------→ $CaCO_3 + 2$ NaCl **1. Cold lime- soda process**: In this method, a calculated quantity of lime and soda are mixed with water at room temperature. At this temperature, the precipitate formed are very fine and require more time for settling Some coagulants like alum or sodium aluminate are added to water for settling. In **batch process** raw water and calculated quantities of soda and lime are added to tank and thoroughly mixed, calculated quantities of coagulants are added to tank. The contents of the tank are kept undisturbed for few hours which allows coagulation and settling of	1 2 5 marks for any one with diagram	8

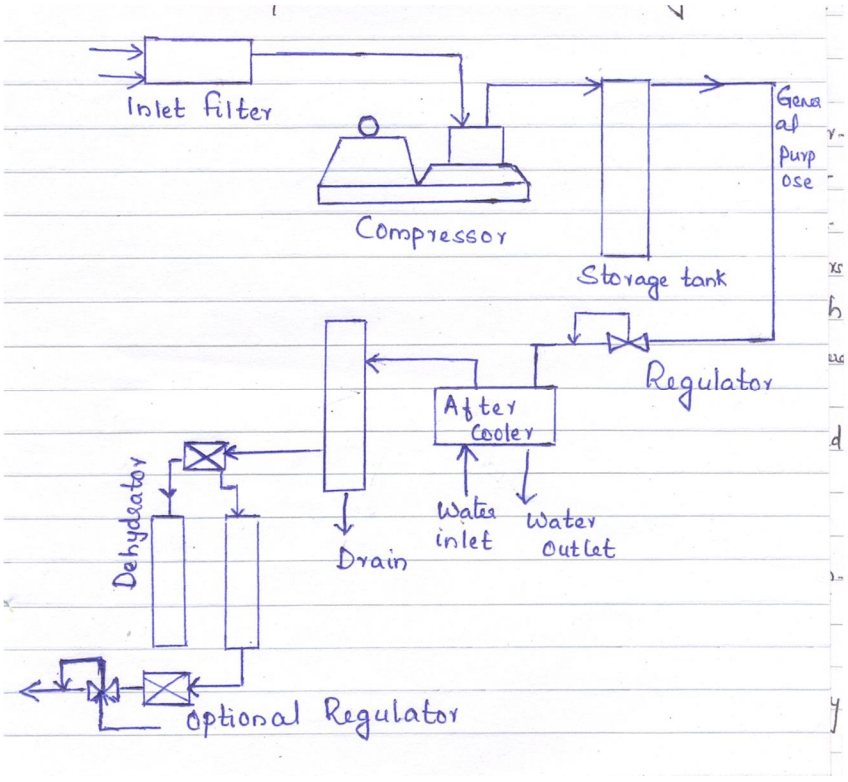
	precipitate. The clear, softened water is collected and send to filtering unit. In **continuous process**, the raw water and calculated quantities of chemicals are continuously fed from the top into an inner chamber provided with a stirrer. The water and chemicals flowing down the chamber and chemical reaction takes place to soften the water. The sludge formed settles down at the bottom of outer chamber from where it is removed through sludge outlet. The softened water passes through the filter which removes traces of sludge and filtered water passes through the outlet.  **2. Hot lime soda process:** In hot lime soda process, raw water is treated with softening chemicals at 80^0C to 100^0C. At this temperature the chemical reactions are fast and hence less capacity tanks are required. The sludge formed settles down easily, hence there is no need of adding coagulants. ***Description for any one process with diagram should be given marks***		
2.b	**Vapour Absorption refrigeration cycle:** In absorption system the compressor in the vapor compression cycle is	5	8

	replaced by an absorber- generator assembly involving less mechanical work. Ammonia is the refrigerant and water is the absorbent. Ammonia vapor is vigorously absorbed in water. So low pressure ammonia vapor from the evaporator comes in contact in the absorber with a weak solution coming from the generator, it is readily absorbed releasing the latent heat of condensation . The temperature of the solution tends to rise, while the absorber is cooled by the circulating water , absorbing the heat of solution, Q_A and maintaining a constant temperature. Strong solution, rich in ammonia, is pumped to the generator where Q_G is supplied from an external source like steam, electricity etc. Since the boiling point of ammonia is less than that of water, the ammonia vapor is given off from the aqua- ammonia solution at high pressure and the weak solution returns to the absorber through a pressure reducing valve. The heat exchanger preheats the strong solution and cools the weak solution, reducing both Q_A& Q_G. The ammonia vapor then condenses in the condenser, is throttled by the expansion valve, and then evaporates absorbing the heat of evaporation from the surroundings. **Diagram:**  	3	
2.c	**Boiler mountings:** 1. Water gauge or water level indicator 2. Pressure gauge 3. Fusible plug	2	8

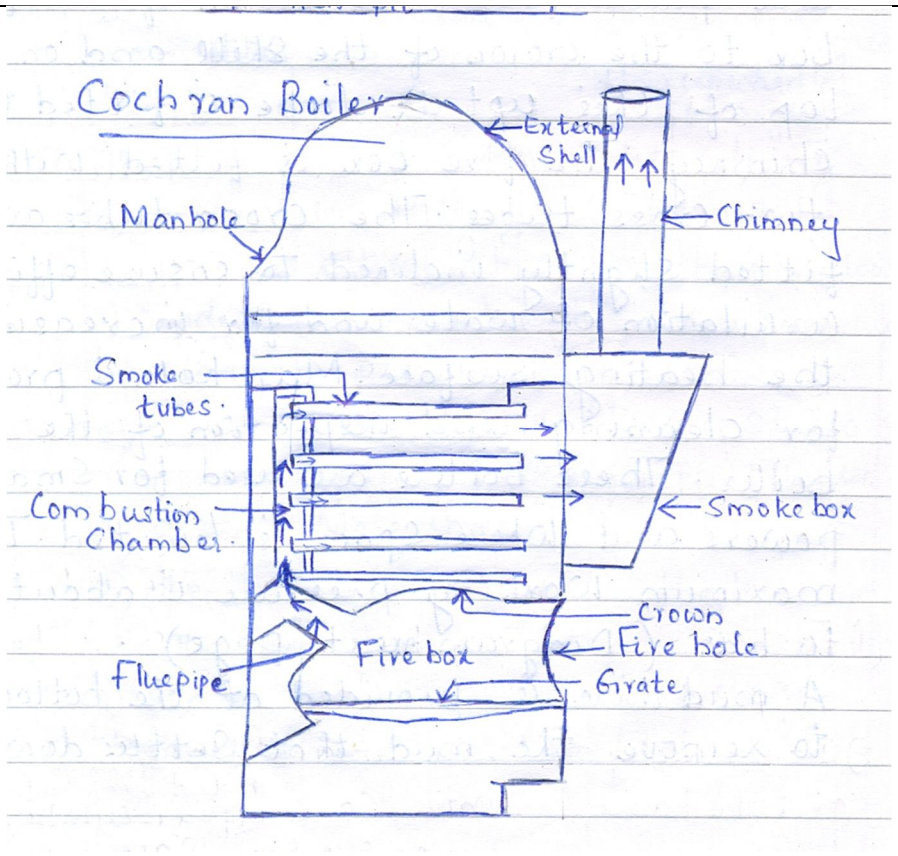
	4. Lever safety valve **Boiler Accessories:** 1. Pressure reducing valve 2. Steam trap 3. Steam separator 4. Economiser 5. Superheater Description of any one type of boiler mounting or accessory with diagram	2 4	
3.a	<table><tr><th>Sensible heat</th><th>Latent heat</th></tr><tr><td>It is the amount of heat required to raise or lower the temperature of a substance.</td><td>It is the amount of heat required to change the phase of a substance at constant temperature</td></tr><tr><td>Phase remains same</td><td>Phase change occurs.</td></tr><tr><td>Temperature changes</td><td>Temperature remains same</td></tr><tr><td>$Q= m.Cp.\Delta T$</td><td>$Q= m.\lambda$</td></tr></table>	1 mark each	4
3.b	**Reversed Carnot cycle:** In this cycle, work of expansion in the expansion cylinder is utilized as input energy to the compressor. Line 3-4 shows the expansion process. During the expansion process, the pressure of the refrigerant drops from P_3 to P_4 ant its temperature from T_3 to T_4 and a fraction of refrigerant vaporizes. The expansion process is isentropic. During the next part of the cycle, the refrigerant is evaporated at constant pressure $P_4 = P_1$ and constant temperature $T_4 = T_1$, which is shown by 4-1.At point 1, the refrigerant is a liquid vapour mixture with small percentage of liquid. This mixture enters the compressor. The compressor raises the pressure of the refrigerant from P_1 to P_2 and the temperature from T_1 to T_2 and the remaining liquid also evaporates so that the refrigerant leaves the compressor as dry saturated vapour at point 2. The final process in the cycle is the condensation shown by 2-3 when the dry saturated vapour	4	4

	at point 2 condenses at constant pressure and constant temperature to point 3.  		
3.c	$T_H = 35^0C = 273+ 35= 308K$ $T_L = -15^0C = 273+ -15= 258K$ COP= $\frac{T_L}{T_H - T_L} = \frac{258}{308-258} = 5.16$	1 3	4
3.d	**Forced draft cooling tower:** In forced draft type air is blown into the tower by a fan at the bottom. These are particularly subject to recirculation of the hot, humid discharged air into the fan intake owing to the low discharge velocity, which materially reduces the tower effectiveness.  	2 2	4

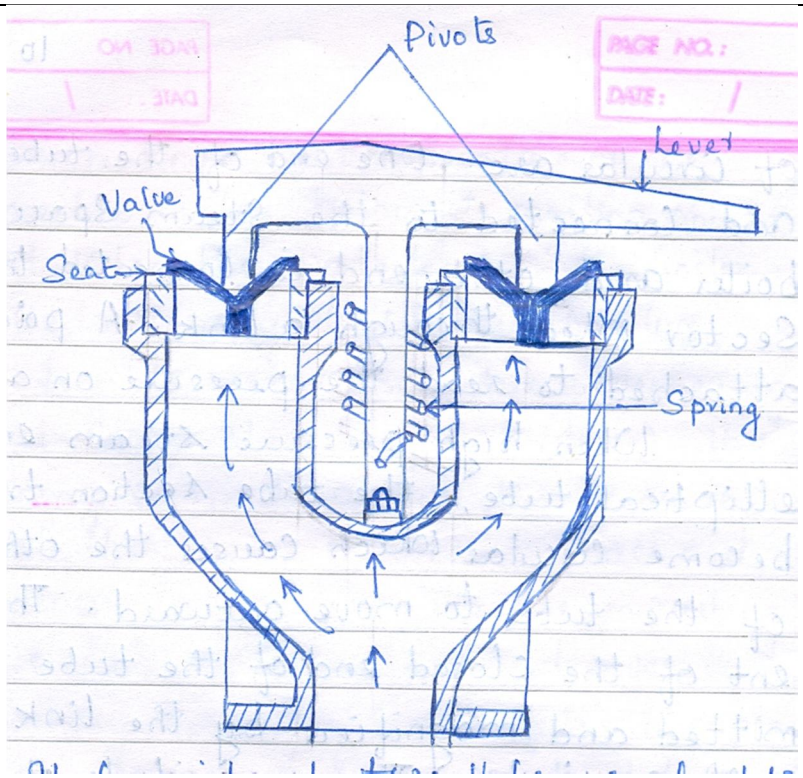
3.e	**Fluidized bed boiler:** In fluidized bed boiler, the solid fuel or waste material is in suspension with help of air. The major problem with the coal fired boiler containing higher sulfur is to suppress the SO_2 formed before exhausting the gases into the atmosphere as it is highly poisonous to human health and crops. The FBB permits the injection of limestone directly into the furnace which can easily capture SO_2. This eliminates the need for expensive flue gas scrubbing system downstream of the boiler. **Diagram:**  	2 2	4
3.f	**R-22:** R-22 is monochlorodifluoromethane($CHClF_2$) or Freon-22 **Properties of R-22:** 1. Stable 2. Non toxic 3. Non corrosive 4. Non irritating 5. Non inflammable 6. Boiling point 0f -40.8^{0}C at atmospheric pressure	2 ½ marks each for any four	4

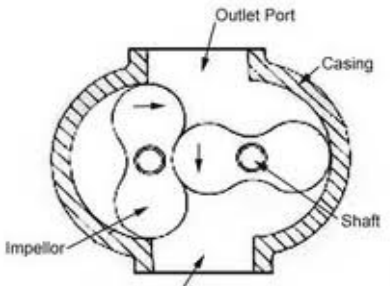
	Good solubility in oil up to -10^0C		
4.a	**Construction and working of dowtherm heater:** It consists of burner, tube coils, armatures, safety and control panel etc. Heaters or burners are insulated with stainless steel cover sheets. Heaters are made with coils of seamless tubes. The combustion chamber has an inner cylindrical tube coil and flat tube coils forms the chamber wall and bottom respectively. The thermal design ensures unlimited thermal expansion due to high fluid temperature The thermic fluid is heated during the flow through the tubes. Heat is transferred to the oil by radiation from combustion chamber. The combustion gases get cooled when it passes through the space between the tubes.	2+2	4
4.b	Process for getting instrument air  Air is passed through a filter to remove suspended impurities, which is then supplied to compressor. The compressed air which is at a pressure of 100 to 150 psi is stored in a storage tank. When required, it is passed	2 2	4

	through a regulator and then through an after cooler to remove the heat. It is then passed through a stone filter to remove the traces of oil if present. Filtered air is passed through a dehydrator (using silica gel, activated alumina etc) to remove the moisture. A second pressure regulator is sometimes added to provide a constant reduced pressure in the supply line.		
4.c	**Fire tube boiler:** **Cochran boiler:** It consists of a cylindrical shell with its crown having a hemispherical shape to with stand steam pressure. Fire box is constructed in one piece and has no joints. The hot products of combustion from fire box enters through a small flue pipe into the combustion chamber. From there it passes through smoke tubes and enters the smoke box and then to the uptake of chimney. Man holes are provided around the top of the crown for cleaning purpose.	2	4

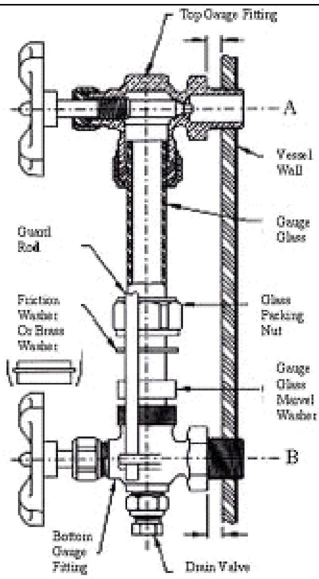
	 ***Marks should be given in the above format for any other fire tube boiler***	2	
4d	Thermic fluid heater is preferred when the temperature requirement is high which cannot be economically met by steam. **Thermic fluid is preferred over steam due to the following reasons**: 1. For getting high temperature with water(steam), high pressure is required. Since thermic fluids have high boiling points, high temperature can be obtained at moderate pressures. 2. Thermic fluids have high stability. 3. They are economical 4. No equipment for pretreatment of boiler feed water. 5. No heat loss due to condensate and flash steam. 6. No risk of corrosion and no risk of freezing damages. Low maintenance cost.	2 ½ mark each for any four points	4
4.e	**Construction and working of centrifugal compressor:**	**4**	4

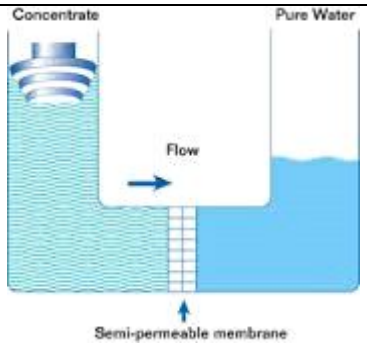
	Centrifugal compressors are multistage units containing a series of impellers on a single shaft which rotates at high speed in a casing. The gas flows into the eye of the impeller, where it is accelerated, leaving at high velocity at the outer edge and flowing into a diffuser which converts the kinetic energy into pressure energy. The gas is then directed to the eye of the next impeller. Cooling is provided for removing the heat of compression.		
4.f	Spring loaded safety valve It consists of two valves, each of which is placed over a valve seat fixed over a branch pipe. The two branch pipes are connected to a common block which is fixed on the shell of the boiler. The lever has two pivots, each of which is placed over each respective valve. The lever is attached with a spring at its middle which pulls the lever in the downward direction. The valves are held tight to their seats by the spring force. These valves are lifted against the spring when the steam pressure is greater than the working pressure and allows the steam to escape from the boiler till the pressure in the boiler reaches its working pressure.	2	4

	 ***Marks should be given in the above format for any other type of safety valve.***	2	
5.a	Glasswool Thermocole Cold insulation High vacuum insulation Multiple layer powder insulation rigid foam insulation it shoud be stable mechanically,odourless,cost shoud be low,fire proof,resist, moisture absorbtion	2 2	4
5.b	1 ton of refri.= 211 KJ/min W.D.= 1.3 KW = 1.3 KJ/s = 1.3 x 60 KJ/min heat absorbed = 14000 KJ/Hr = 14000/60 KJ/min	2	4

	=233.33 KJ/min C.O.P. = Heat absorbed/WD =233.33/(1.3 X 60) = 2.9914 C.O.P. = T1/(T2-T1) 2.9914 = 235 / (T2-235) T2 = 41 deg. C	2	
5.c	 Roots Blower Working:- The Root's Blower / Vacuum pump consists 2 triple lobe of rotors and rotate in synchronous and opposite direction by two timing gear. The two rotors are assembled with casing two side plates and keep small gaps and no contact rotation between the casing and two rotors, and two side plates, when motor output to drive rotor and start working. The two rotors rotate in synchronous and opposite and continue to turn and suction a quantity of gas between the rotating rotors, casing and side plates continue rotation carry the trapped volume around the rotor and casing out the discharge port.	2 2	4
5.d	i)certificate of renewal: after 12 months, in case of boiler transferred from one state to another, in case of boiler accidents, any alteration in boilers	1	4

	ii)Boier accidents: boiler occupier should inform boiler accident to chief inspector, inspector carried out investigation and decide to permit the use of boiler iii)Transfer of boiler: boiler transferred from one state to another state ,permission must be taken from inspector of new state iv)Boiler repair: before repairs the boiler , permission must be taken from chief inspector, major repairs carried in presence of inspector.	1 1 1	
5.e	Scale formation or scaling Corrosion Priming and foaming Caustic embrittlement	1 1 1 1	4
5.f	i) DPT : is temp.to which air must be cooled at cons. pressure in order to cause condensation of any of its water vapours. ii) WBT: is temp. read by ordinary thermometer when bulb is covered with wetted wick. iii) DBT: is temp. read by ordinary thermometer . iv) Sp.humidity: is the ratio of mass of water vapours to mass of dry air	1 1 1 1	4
6.a	COP is defined as the ratio of refrigeration effect to the work input. COP = R.E./W.D. COP = T1/(T2-T1) R.E.= Heat absorbed by refrigerator in KJ/s W.D.= Heat rejected – heat absorbed in KJ/s T1 = lower Temp in K T2= higher Temp. in K	2 2	4

6.b	Sp. Enthalpy = hf + x.hfg = 62.94 + 0.8 x 2466.1 = 2035.82 KJ/Kg Sp. Entropy = sf + x.sfg = 0.2243 + 0.8 x 8.5583 = 7.07 KJ/KgK	2 2	4
6.c	Scale are removed by scrapper, by knife blade, by piece of wood etc. brittle scale removed by mech. And thermal shocks , hard scale removed by chemicals e.g. HCl	1 1 1 1	4
6.d	 It consists of a glass tube, two gun metal tubes and three cocks. The steam cock C1 is provided on the gun metal tube M1 which connects the glass tube with the steam space in the boiler. The water cock C2 is provided on the gun metal tube M2 which connects the glass tube with the water space. The gun metal tubes M1 and M2 are bolted to the boiler shell. The drain cock C3 is used to drain the water from the glass tube at intervals to ascertain whether the gauge is in proper order or not. The	2 2	4

	glass tube is protected by means of a cover, made of specially toughened glass which will prevent any accident that may happen due to the breaking of glass tube. Working of Water gauge: The water gauge shows the level of water in the boiler drum. It warns the operator if the water level goes below a fixed mark, so that corrective action may be taken in time to avoid any accident. For the observation of the water level in the boiler, the water and steam cocks are opened and drain cock is closed. The steam enters from the upper metal tube M1 into the glass tube and water enters from the lower metal tube M2 into the glass tube. Hence, water stands in the glass tube at the same level as in the boiler. The junctions of the metal tubes and the glass tube are provided with two balls. In case the glass tube is broken, the balls are pushed to the top nd bottom ends of the glass tube. Thus the flow of both water and steam out of the boiler is prevented. When the boiler is not working, the water gauge can be taken out from the boiler for cleaning purposes by removing the bolts.		
6.e		2	4

	Two chambers are separated by an osmotic membrane.right hand compartment has pure water in it.left hand compartment has salt solution in it. if left alone pure water flows from the pure water compartment to the salt solution compartment. Then flow of water is stop. In applied on the salt solution compartment , then first drop of the pure water flows from the solution compartment into the pure water compartment , when the applied p is equal the osmotic p value of the solution.applied P must be greater than osmotic P. is the concept of R.O.	2	