WINTER-15 EXAMINATION

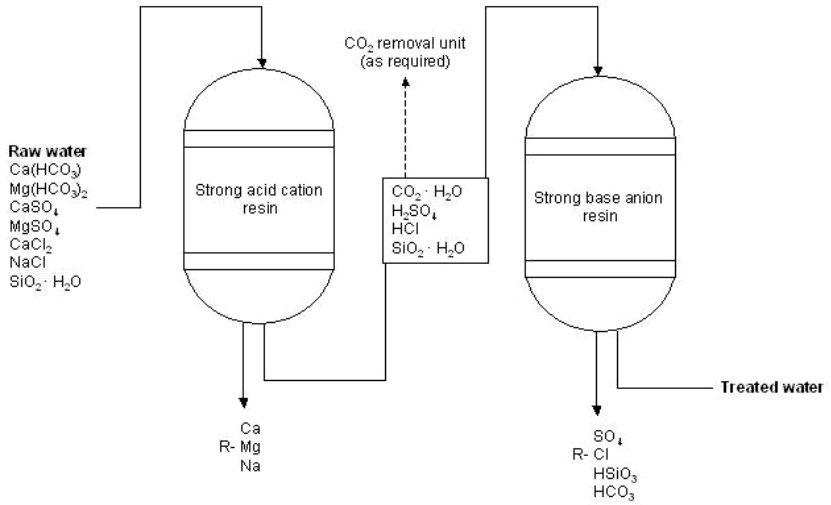
Model Answer

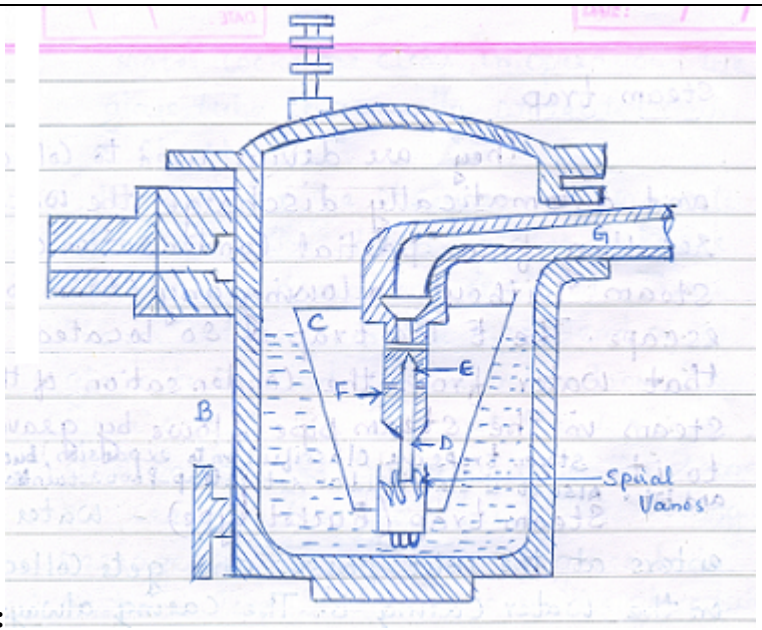
Important Instructions to examiners:

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.

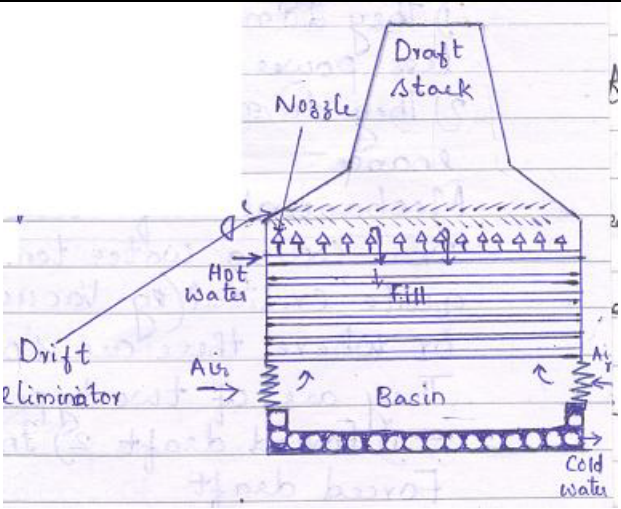
Q No.	Answer	Marks	Total marks
1a-i	**Uses of water in domestic purpose** 1. Washing 2. Cooking 3. Cleaning **Uses of water in industrial purpose** 1. As Coolant 2. In chemical reaction 3. Cleaning	½ mark each for any two ½ mark each for any two	2
1a-ii	**Salts causes temporary hardness:** Bicarbonates of calcium and magnesium Temporary hardness can be destroyed by boiling of water. During boiling, the bicarbonates are decomposed to get insoluble carbonates or hydroxides which deposits at the bottom.	 1 1	2
1a-iii	**Unit of refrigeration** is **Ton of refrigeration**: It is defined as the quantity of heat required to be removed from 1Ton water at 0^oC to get ice at 0^oC in one day	2	2
1a-iv	**Sensible heat** : It is the heat required to change the temperature of any substance .It can be calculated by $Q=mC_p\Delta T$ **Latent heat** : It is the heat required to change the phase of any substance at constant temperature . It can be calculated by $Q=m\lambda$	1 1	2
1a-v	**Classification of boiler based on furnace position**		2

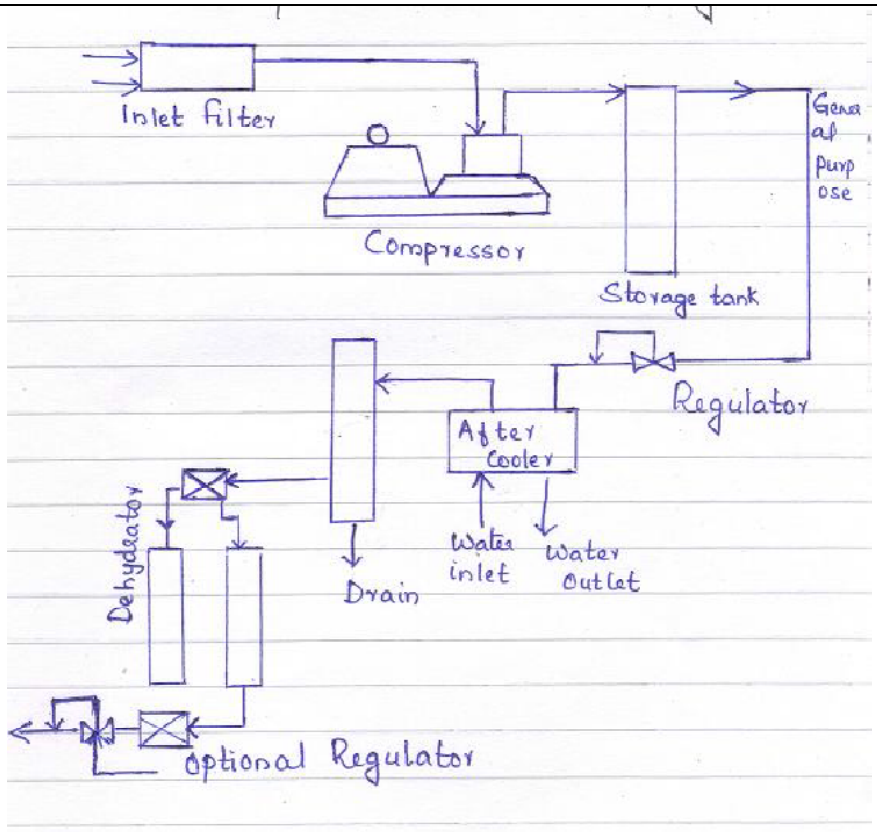
	a. Externally fired boiler: When combustion takes place outside the region of boiling water. Ex.- Babcock & Wilcox boiler b. Internally fired boiler: If the furnace region is completely surrounded by water cooled surface. Ex.Lancashire boiler	1 1	
1a-vi	**Industrial Uses of air:** 1. Used in chemical process in oxidation reactions. 2. Used in automatic controllers to control the process. 3. Used in the production of oxygen and nitrogen. 4. Used in refrigeration system. 5.Used for drying purpose 6. Used in furnace, boilers 7. Used in the manufacture of chemicals like sulphuric acid, nitric acid etc. 8. Used for driving tools like pneumatic hammers. 9. Used in cooling tar	½ mark each for any four	2
1a-vii	**Uses of thermic fluid:** (1)High temperature can be obtained at moderate pressure (2) Have wide range of operation stability. (3) More economical at high temperature.	1 mark each for any 2	2
1b-i	**Diagram of Ion exchange process:**	4	4

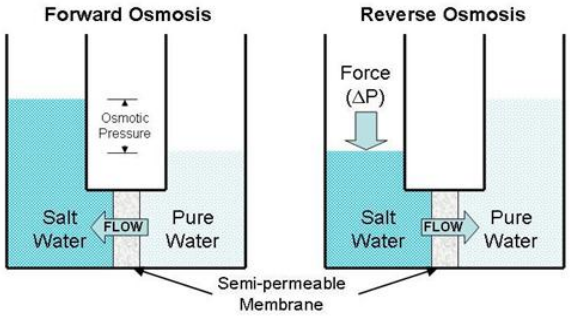
			
1b-ii	**Classification of refrigerants:** A. National Refrigeration Safety Code, USA classifies all the refrigerants into 3 groups 1.Group 1 refrigerants (safest) Ex. CCl_3F, 2. Group2 refrigerants (toxic and somewhat inflammable) Ex. Ammonia, methyl chloride 3. Group3 refrigerants (Inflammable refrigerants) Ex. Butane, ethane B. National board of Fire Underwriters USA classifies refrigerants on the basis of their toxicity. There are six divisions on this scale. Class 1 is the most toxic and class 6 is least toxic C. Refrigerants are also classified as Primary refrigerants Ex. CCl_3F, CCl_2F_2 and secondary refrigerants	4	4
1b-iii	**Bucket type steam trap:** **Use:** They are used to collect and automatically discharge the water resulting from partial condensation of steam without allowing any steam to escape.	1	4

	 **Diagram:** B-casing C-bucket D- spindle E- Valve F- Seat G- exit pipe Working: The condensed water enters the casing and the level of water in the casing rises which further raises the floating bucket and ensures proper closing of the valve. As soon as the water from the casing overflows in the bucket, due to additional weight of water the bucket sinks down in the casing and as a result the valve opens. The steam pressure acts on water in the bucket and water is forced up the guide tube through vanes and rushes out through the exit pipe. The flow of water through spiral vanes rotates the bucket. As soon as all the water in the bucket is forced out, the bucket again floats up and and closes the valve.	3	
2-a	**Priming**: It is the phenomenon of very rapid boiling of water inside the boiler with the result that the water particles mixed up with steam. It is due to the presence of large quantities of dissolved organic oily matter, suspended material etc.	2	4

	Foaming : It is the phenomenon of formation of foam or bubbles on surface of water which do not break easily. **These can be prevented by** i)controlling the concentration of impurities inside the boiler ii)By keeping the level of water as low as possible. iii) By addition of anti foam agents.	2	
2-b	**Desirable properties of ideal refrigerant:** 1. It should be chemically inert. 2. It should be non-flammable, non-explosive and non-corrosive. 3. It should not react with lubricating oil. 4. It should not have bad effect on the stored material. 5. It should not decompose at temp. normally encountered in the system. 6. It should be non toxic and stable	1 mark each for any four	4
2-c	**Inspection of boiler:** Boiler is inspected before the certificate for its operation is given to its employer. Before inspecting the boiler, It is clean All fittings , such as burners , stokers, etc are removes Valves, cocks etc are open & inspector examine all the parts of boiler, carries the hydraulic test , where the water pressure is raised to hydraulic test pressure of 1.5 psi When the hydraulic test pressure is reached, the boiler is inspected for water leakage if any.	4	4
2-d	**Natural circulation cooling tower:**	2	4

	 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 then required. Both these tower types 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.	2	
2-e	**Process of getting instrument air:**		4

	 Air is passed through a filter to remove suspended impurities. The filtered air is supplied to the compressor. Discharge from the compressor will be at a pressure of 100 to 150 psi, which is stored in a storage tank. When required it is passed through a regulator and then through an after cooler to remove the heat. It is then passed through a stone filter to remove traces of oil if present. Filtered air is passed through dehydrator to remove the moisture. Silica gel, activated alumina, calcium chloride, glycol etc are used for removing the moisture. A second pressure regulator is sometimes added to provide a constant reduced pressure in the supply line	2 2	
2-f	**Reverse osmosis:**	2	4



Description:

It is the process of filtration. In this , we take water with salt in it , an apply pressure to it against a certain type of membrane and presto out comes clean water.

Two chamber are separated by an osmotic membrane. Right hand compartment has pure water in it. Left hand compartment has salt solution. If left alone , pure water floe in the direction of the arrows from the pure water compartment into salt solution compartment. Pressure heas in the salt solution compartment continue to rise until it reaches a value represented by the osmotic pressure of the solution. Then flow of water stops.

In the same chamber divided by the osmotic membrane , if increasing pressure is applied on the salt solution compartment in the direction of the arrow , then the first drop of pure water flows in the direction of the arrow from the solution compartment to the pure water compartment when the applied pressure equal the osmotic pressure value of the solution. The applied p must be much greater than the osmotic pressure.

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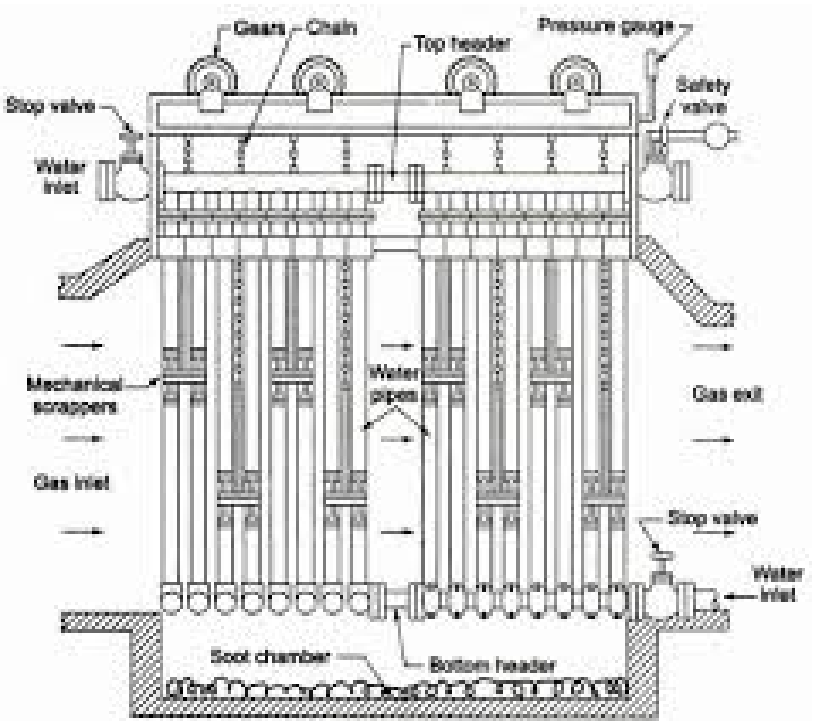
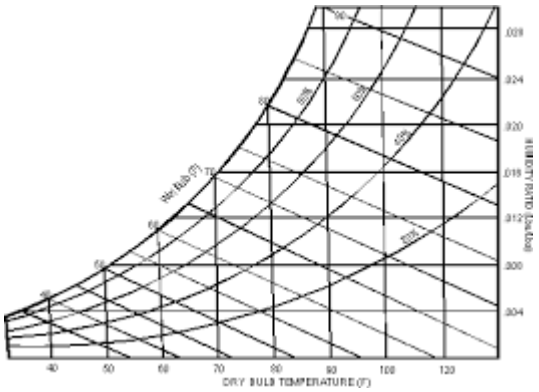
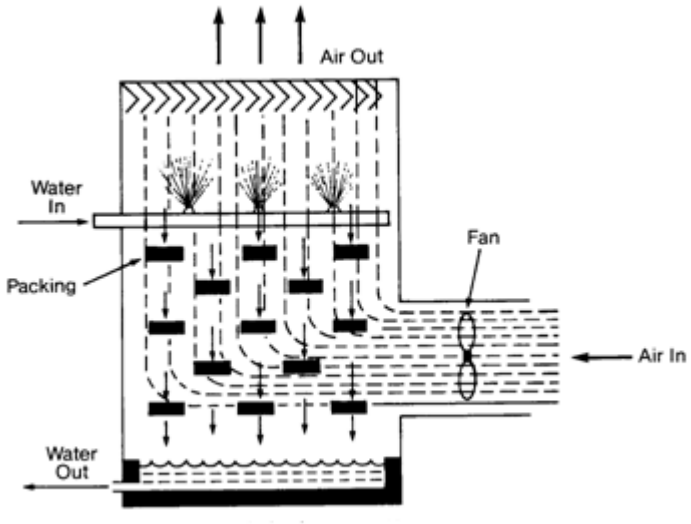
2

	Two chamber are separated by an osmotic membrane. Right hand compartment has pure water in it. Left hand compartment has salt solution. If left alone , pure water floe in the direction of the arrows from the pure water compartment into salt solution compartment. Pressure heas in the salt solution compartment continue to rise until it reaches a value represented by the osmotic pressure of the solution. Then flow of water stops. In the same chamber divided by the osmotic membrane , if increasing pressure is applied on the salt solution compartment in the direction of the arrow , then the first drop of pure water flows in the direction of the arrow from the solution compartment to the pure water compartment when the applied pressure equal the osmotic pressure value of the solution. The applied p must be much greater than the osmotic pressure.		
3-a	**R-22** means Chlorodifluoromethane or difluoromonochloromethane is a hydrochloroflurocarbon (HCFC). R-22 is often used as an alternative to the highly ozone-depleting CFC, because of its relatively low ozone depletion potential of 0.055. USES: Used in air-conditioning units and commercial purpose. Used in fast freezing units Used for industrial low temperature refrigeration as low as -90 deg.C Properties: R-22 is miscible with oil at condenser temperature ,but tries to separate at evaporator temperature when the system is used for low temperature application. The solubility in water three times greater than R-12 The compressor displacement is 60 % less with R-22	2 1 1	4

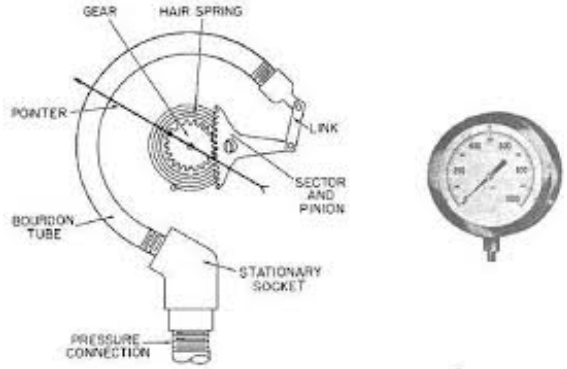
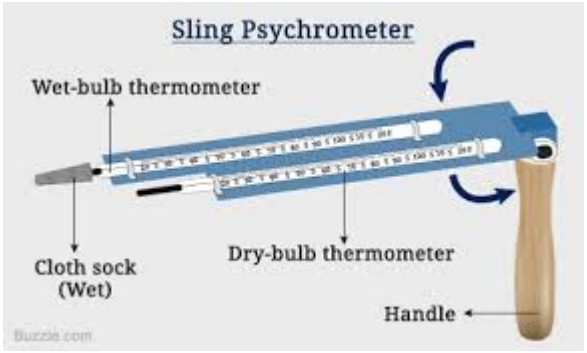
	A compressor gives 60 % more refrigerating effect with R22 This property reduces the size of pipe line required with R22 Toxicity of R22 ia same as CO2		
3-b	**Economizer:**  **An economizer is a device used to heat feed water by utilizing the heat in the exhaust flue gases before leaving through the chimney. Economizer improves the economy of the steam boiler.** Due to the passage of the flue gas through the economiser, soot is likely to collect on the tubes and return the heat transfer from hot gases o water in the tubes. Therefore continuously these tubes are scraped by scraper to remove soot collected on them. A pair of scraper for two adjacent tubes is coupled together and moves simultaneously up and down scraping the soot from the tubes. A pair is connected by a chain passing over a pulley.it always move such that one	2 2	4

	scraper comes down and the other attached to the same chain goes up. Thus the motion of the pulley is automatically, intermittently and timely reversed.scrappers move very slowly and continuously .soot chamber collect the soots and remove through door.		
3-c	**Psychrometric chart**  The dry bulb temp. is indicated by vertical lines drawn parallel to the ordinate. The mass of water vapour in kg per kg of dry air is drawn parallel to the abscissa for different valued of dry bulb temp. Pressure of water vapour in mm of Hg is shown in the scale at left and is the absolute pressure of steam. Dew point temp. Re shown in the scale on the upper curved line. Constant RH Lines in per cent are indicated by marking off vertical distances between the saturation line or the upper curved lines and the base of the chart **Uses:** The psychrometric chart are prepared to represent graphically all the necessary moist air properties, used for air conditioning calculations. The values are based on actual measurements verified for thermodynamic consistency	2 2	4
3-d	**Forced Draft Cooling tower:**		4

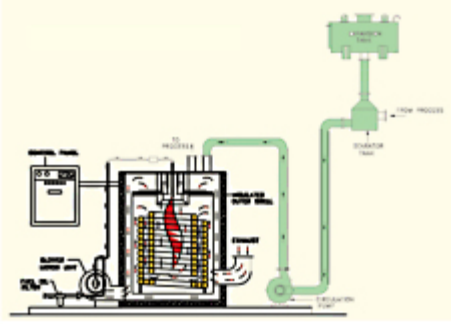
	 **Construction and working**: A cooling tower is a heat rejection device which rejects waste heat to the atmosphere through the cooling of water stream to a lower temperature. Cooling towers may either use the evaporation of water to remove process heat and cool the working fluid to near the wet-bulb air temperature or, in the case of closed circuit dry cooling towers, rely solely on air to cool the working fluid to near the dry-bulb air temperature. Forced draught — A mechanical draft tower with a blower type fan at the intake. The fan forces air into the tower, creating high entering and low exiting air velocities. The low exiting velocity is much more susceptible to recirculation. With the fan on the air intake, the fan is more susceptible to complications due to freezing conditions. Another disadvantage is that a forced draft design typically requires more motor horsepower than an equivalent induced draft design. The benefit of the forced draft design is its ability to work with high static pressure. Such setups can be installed in more-confined spaces and even in some indoor situations. This fan/fill geometry is also known a blow through	2 2	
3-e	**Advantages of multistage compression:**	1 mark	4

	1.Reduction in power required to drive compressor. 2.Better mechanical balance and uniform torque 3.Reduced leakage loss swing to reduce pressure difference in either side of piston and valve. 4. Less difficulty in lubrication. 5. Lighter cylinders.	each for any 4	
3-f	**Boiler act:** (**i) duties of chief inspector:** Maintained record of registered boiler Examine boiler inspection report produced by inspector Decide whether to issue certificate for the operation of boiler or not Supervise and control the work of inspector **(ii) transfer of boiler:** When boiler is transferred from one state to another , permission must be taken again from the chief inspector of new state for its installation and operation. **(iii) registration of boiler:** Boiler have to be registered before they can be used , the owner of the boiler shall give an application for the same.the inspector shall examine the boiler and find the maximum pressure at which the boiler may be operated . He will submit his report to the chief inspector And in turn the employer may get authorized for 1 year to use the boiler. The employees shall not use for higher pressure than that permitted by the chief inspector. **(iv) certificate of renewal:** After generally 12 months. If boiler is transferred from one state to another. If some accidents is occurs.	1 1 1 1	4

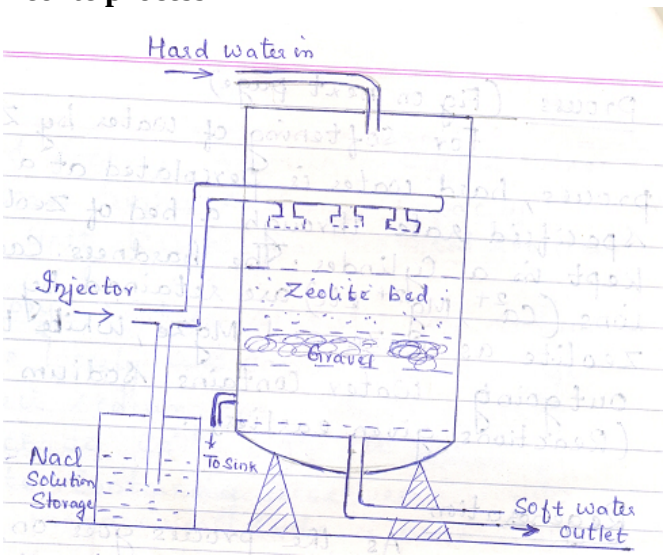
	If some alteration is done in boiler parts , etc.		
4-a	**Reaction with hard water and lime soda:** $2\ HCl + Ca(OH)_2 \rightarrow CaCl2 + 2\ H_2O$ $H_2SO_4 + Ca(OH)_2 \rightarrow CaSO_4 + 2\ H_2O$ Lime remove temporary hardness: $Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 + 2\ H_2O$ $Mg(HCO_3)_2 + 2\ Ca(OH)_2 \rightarrow 2CaCO_3 + Mg(OH)_2 + 2\ H_2O$ LIME remove mg salt: $MgCl2 + Ca(OH)_2 \rightarrow Mg(OH)_2 + CaCl_2$ LIME remove iron and Al salts: $FeSO_4 + Ca(OH)_2 \rightarrow Fe(OH)_2 + CaSO_4$ Lime remove CO_2 $Ca(OH)_2 + CO_2 \dashrightarrow CaCO_3 + H_2O$	4	4
4-b	**BRINES:** Brine is a solution containing a salt in dissolved condition in water. **Properties:** $CaCl_2$ brine is used for temperature below - 20 deg . C They are non-corrosive even in presence of water They will not evaporate during service being extremely stable. **Uses:** Used for cooling and ice making plants. Used for freezing a meat and fish.	2 1 1	4
4-c	**Pressure Gauge:**	2	4

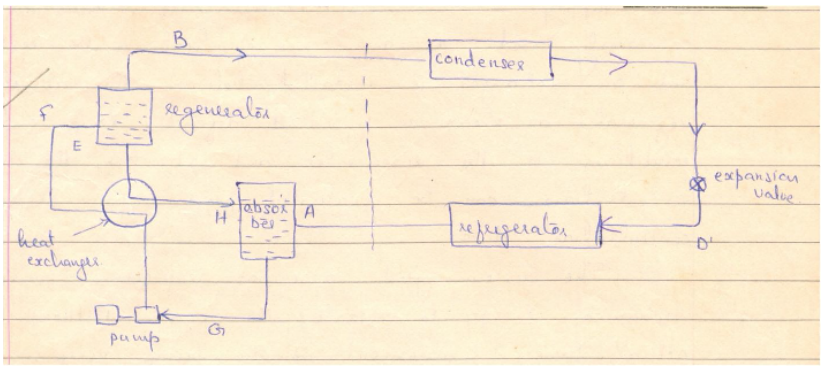
	 Spring tube ,elliptical in cross section made high quality phosphor bronze, one open end is connected via the hollow block and the other end is closed. Hollow solid block communicating the stem space via U tube siphon Link connecting the closed loose end of spring to the quadrant. Quadrant with teeth cut on the side opposite to which link is connected. Point for the quadrant so located that displacement of link connection is magnified the motion of the closed end of the spring is modified. Pointer mounted on the spindle fixed to the pinion, which moves on the graduated scale as the pinion moves. Pinion with spindle meshing with the toothed quadrant. The gauge is connected to the boiler steam space through U tube syphon	2	
4-d	**Sling psychrometer:** 	2	4

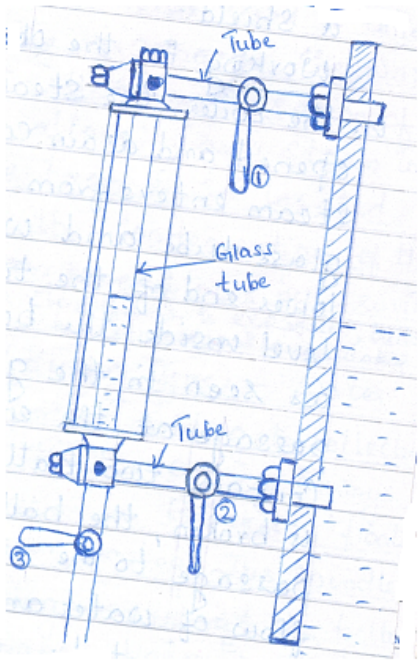
	The sling psychrometer consist of 2 thermometers mounted on a base plate. The one with the sock is WBT the other is dry bulb. The wet bulb exists below thw dry bulb.this is done perposely so that sock can be dipped in water without wetting the dry bulb. The handle of the frame help for rotating psychrometer to produce necessary air motion.fast motion of air past the sock is necessary to bring the air at temp. DBT, Always in immediate contact with the wet sock. The temp. Spreads between DB and WB readings depends upon the amount of moisture in the air.	2	
4-e	**Thermic Fluid Heater :** In recent times, thermic fluid heaters have found wide application for indirect process heating. Employing petroleum - based fluids as the heat transfer medium, these heaters provide constantly maintainable temperatures for the user equipment. The combustion system comprises of a fixed grate with mechanical draft arrangements. The modern oil fired thermic fluid heater consists of a double coil, three pass construction and fitted a with modulated pressure jet system. The thermic fluid, which acts as a heat carrier, is heated up in the heater and circulated through the user equipment. There it transfers heat for the process through a heat exchanger and the fluid is then returned to the heater. The flow of thermic fluid at the user end is controlled by a pneumatically operated control valve, based on the operating temperature. The heater operates on low or high fire depending on the return oil temperature, which varies with the system load.	4 Diagram not necessary	4

	 Fig: A typical Configuration of Thermic Fluid Heater Reference: http://www.warmstream.co.in/prod-en-thermic-fluid-heaters.html		
4-f	T1 = 25 + 273 = 298 T2 = -15 + 273 = 258 C.O.P. = T2/(T1 - T2) = 258 / (298 - 258) = 6.45	1 1 2	4
5-a	**Principle used in air refrigeration:** The principle used is adiabatic expansion. Ie if a gas is allowed to expand suddenly from a high pressure to a low pressure adiabatically, the gas cools drastically. In air refrigeration cycle, air is the refrigerant and it always remain in gaseous state and does not condense in any part of cycle. Air used as the refrigerant is used to remove the heat from the refrigerated space and discharge the same into atmosphere which is at higher temperature than the refrigerated space.	4	4
5-b	**Enthalpy of dry saturated steam.** It is the quantity of heat required to raise the temperature of 1 kg of water from the freezing point to the boiling point and then convert it into dry saturated steam at that temperature and pressure. **Enthalpy of superheated steam.** It is the quantity of heat required to raise the temperature of 1 kg of water from	2 2	4

	the freezing point to the boiling point and then convert it into superheated steam at that pressure.		
5-c	**Boiler mountings:** They are equipment mounted on the boiler for the safe working of boiler. **Different boiler mountings:(any two)** 1. Water gauge or water level indicator: it is used to indicate the level of water in the boiler. 2.Pressure gauge: To indicate the pressure inside the boiler. 3.Fusible plug: It is used to protect the fire box crown plate or the fire tube from burning when the level of the water in the water shell falls abnormally low. 4.Safety valve: To release the excess steam to maintain the pressure **Boiler accessories:** They are auxiliary equipments used to improve the overall efficiency and performance of the boiler. **Different boiler accessories are (any two)** 1. Air preheater: It recovers some portion of the waste heat of the flue gases and preheats the air supplied to the combustion chamber. 2. Super heater :They are used in boilers to increase the temperature of the steam above its saturation temperature, 3. Economizer: The function of economizer is to extract the waste heat of the chimney gases to preheat the water before it is fed to the boiler.	1 1 1 1	4
5-d	**(i) Absolute humidity:** It is the weight of water vapour per unit weight of dry air or gas. **(ii)Relative humidity:** Relative humidity is the ratio of actual partial pressure of vapour in the gas to the saturation partial pressure, at a given temperature and volume of gas.	2 2	4
5-e	From the steam table, corresponding to a temperature of 10^0C,		4

	Specific enthalpy of saturated water h_f= 42 kJ/ kg Enthalpy of evaporation L = 2477.9 kJ / kg Dryness fraction x= 0.8 Specific enthalpy of steam = m(h_f + xL) = 1(42 + 0.8* 2477.9) = **2024.32 kJ**	1 1 2	
5-f	<table><tr><th>**Hard water**</th><th>**Soft water**</th></tr><tr><td>1.Contains dissolved salts of calcium and magnesium</td><td>Does not contain dissolved salts of calcium and magnesium</td></tr><tr><td>2.Does not produce lather or foam with soap</td><td>produce lather or foam with soap</td></tr></table>	2 marks each	4
6-a	**Zeolite process**  Zeolites are hydrated sodium alumino silicates, capable of exchanging reversibly their sodium ions with hardness producing ions in water These silicates hold sodium ions loosely and can easily exchange their sodium ions with other cations such as Ca^{2+} , Mg^{2+} For softening of water by Zeolite process, hard water is percolated at a specified rate through a bed of zeolite, kept in a cylinder. The hardness causing ions	3 3	8

	(Mg^{2+},Ca^{2+} etc) are retained by the zeolite as CaZe and MgZe, while the outgoing water contain sodium salts. $CaCl_2$(or $CaSO_4$) + Na_2Ze → CaZe+ 2NaCl(or Na_2SO_4) $MgSO_4$ (or $MgCl_2$) + Na_2Ze → MgZe+ 2NaCl(or Na_2SO_4) $Ca(HCO_3)_2$ (or $Mg(HCO_3)_2$ + Na_2Ze → CaZe (or MgZe) + 2 $NaHCO_3$	2	
6-b	**Vapour Absorption system**  In absorption system the compressor in the vapor compression cycle is 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,	3 5	8

	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.		
6-c	**Water level indicator** **Diagram**  1- steam cock 2-water cock 3-draincock **Construction:** Water level indicator indicates the level of water in the boiler drum and warns the operator if by chance the water level goes below a fixed mark so that corrective action may be taken in time to avoid any accident. It consists of three cocks and a glass tube. The steam cock 1 keeps the glass tube in connection with the steam space and cock 2 puts the glass tube in connection with the water space in the boiler. The drain cock 3 is used to drain out the water from the glass tube at intervals to ascertain that the steam and water cocks are clear in operation.	3 3	8

	Working: The steam and water cocks are opened and the drain coke is closed. The steam enters from the upper end of the glass tube and water enters from the lower end of the tube, so the water level inside the boiler will be the same as seen in the glass tube.	2	