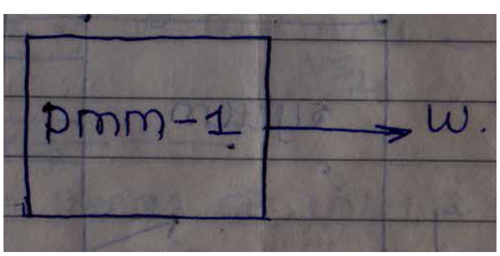
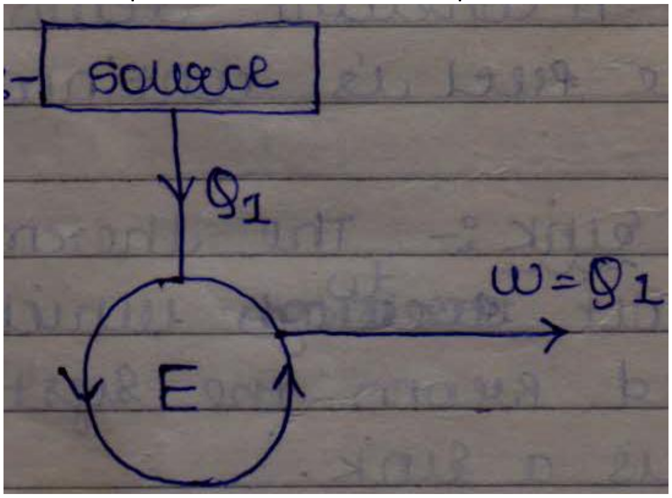
WINTER – 15 EXAMINATIONS

Subject Code:**17554** **Model Answer** Page No: ____/ N

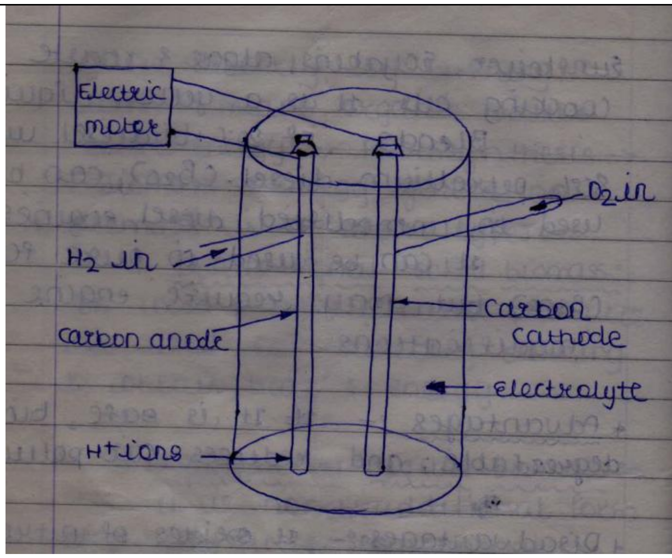
Important Instructions to examiners:

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.

Q. NO.	MODEL ANSWER	MARKS	TOTAL MARKS
1	**Attempt any five**		5x 4=20
a)	Different sources of energy are as follows: (i)Conventional e.g.Coal,Naturalgas,petroleumoil,nuclear fuel etc Application: 1.Power generation 2.Ventilation 3.Home application 4.Comercial (ii)Non –Conventional e.g.Sun,Water,Wind,Animal and vegable waste etc Application: 1.Solar electricity generation 2.Photovoltanic cell 3.Cooking 4.Solar lighting.	1 1 1 1	4
b)	**Kelvin - Planck Statement**. According to Kelvin-Planck 'It is impossible to construct an engine working on a cyclic process, whose sole purposeis to convert heat energy from a single thermal reservoir into an equivalent amount of work. **Clausius Statement**. According to Clausius statement "It is impossible for a self acting machine working In a cycLic process, to transfer heat from a body at a lower temperature to a body at a higher temperature without the aid of an external agency.	2 2	4
c)	PMM -1(Perpetual motion machine of first kind) A machine which violates the first law of thermodynamics is known as PMM -1.It is a machine which produced a work without consuming an equivalent of energy in any other form. Such machine is impossible to construct.  PPM – 2 A heat engine which violates the second law of thermodynamics is known as Perpetual motion machine of second kind. It is 100% efficient machine. It converts whole of heat energy into mechanical work.	2 2	4

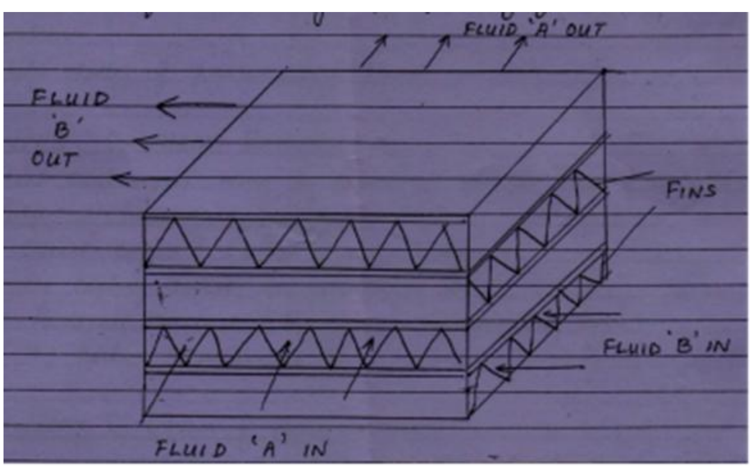
	It is impossible to obtain in actual practice.  		
d)	Classification of Boilers: 1.Depending upon the relative position of water and flue gases: • Smoke tube or fire tube boilers • Water tube boilers: 2. Depending upon the position of furnace: • Internally fired boilers • Externally fired boilers 3. Depending upon the position of axis of the boiler: • Vertical boilers • Horizontal boilers 4. Depending upon the service to which the boilers are put: • Stationary, portable, marine or locomotive boilers etc. 5. Depending upon the source of heat: • Heat generated due to combustion of solid, liquid and gaseous fuels. • Hot waste gases or electrical energy and atomic energy etc. 6. According to method of circulation of water and steam: • Natural circulation • Forced circulation 7. According to pressure of steam generated: • Low pressure • High pressure	1m for each classification (any four)	4
e)	Sources of air leakages: The main sources of air leakages in condenser are given below, a) The air leaks through the joints, packing and glands into the condenser as the pressure inside are below the atmospheric pressure. b) The feed water contains air in dissolved condition. The dissolved air gets liberated when steam is formed and it is carried with the exhaust steam into the condenser.	2	4

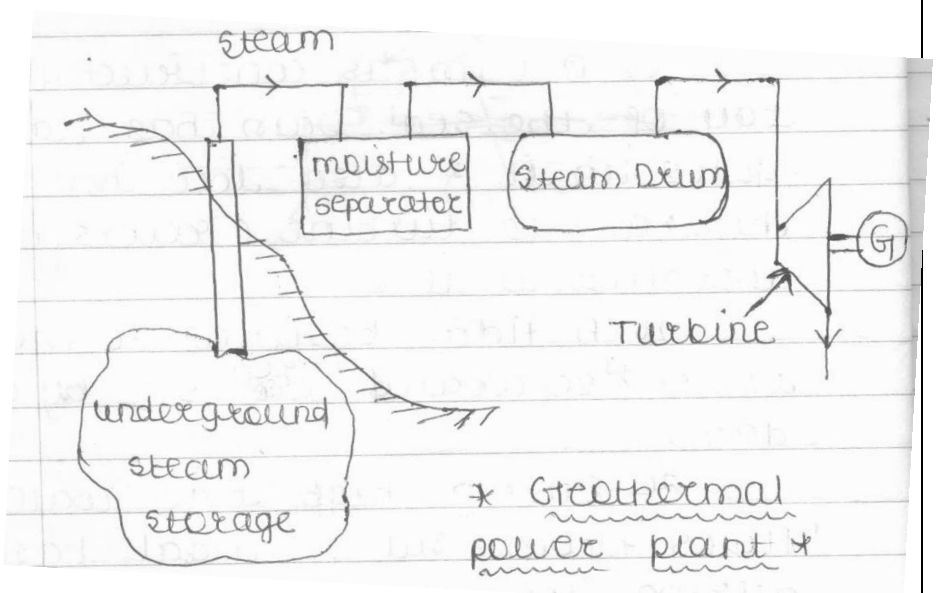
	c) In case ofjet condenser, dissolved air with the cooling water enters into condenser Effects of air leakages in a condenser: a) It increases the back pressure of the prime mover and reduces the work done per kg of steam. b) The partial pressure of steam and its corresponding temperature decreases due to pressure of air. c) Because of poor thermal conductivity of air the rate of heat transfer from the vapour is reduced.	2	
f)	Limitastion of Carnot cycle: 1.Carnot Cycle consists of four processes in the sequences i.e.isothermal,isentropic,isothermal and isentropic In isothemal process has to be very slow.An isentropic process has to very fast.So the sequence of process will be very slow,veryfast,So the sequence of processes will be very slow,veryfast,very slow and very fast.This alternate combination is actual practice is not possible.It is used as reference cycle. 2. It is impossible to complete elimate friction between the various moving aparts of the engine 3.It is impossible to elimate heat losses due to toconduction,radiationetc	2 1 1	4
g)	Applications of Heatexhanger: 1.Dairy industry. 2.Food industries 3.Refrigerattion and airconditing 4.Steam and gas turbine powerplants. 5.Milk chiller and pusteruzing plant. Material used for Heat exchangers 1.Aluminium bronzes. 2.Stainless steel 3.Copper 6.Brass.	2 2	4
2	**Attempt any four**		**4 x 4=16**
a)	Fuel cell is an electrochemical device that converts chemical energy from hydrogen to oxygen into electricity. Fuel cell consists of fuel supply of H_2 and O_2, two carbon electrodes and then electrolyte between the electrodes.		4

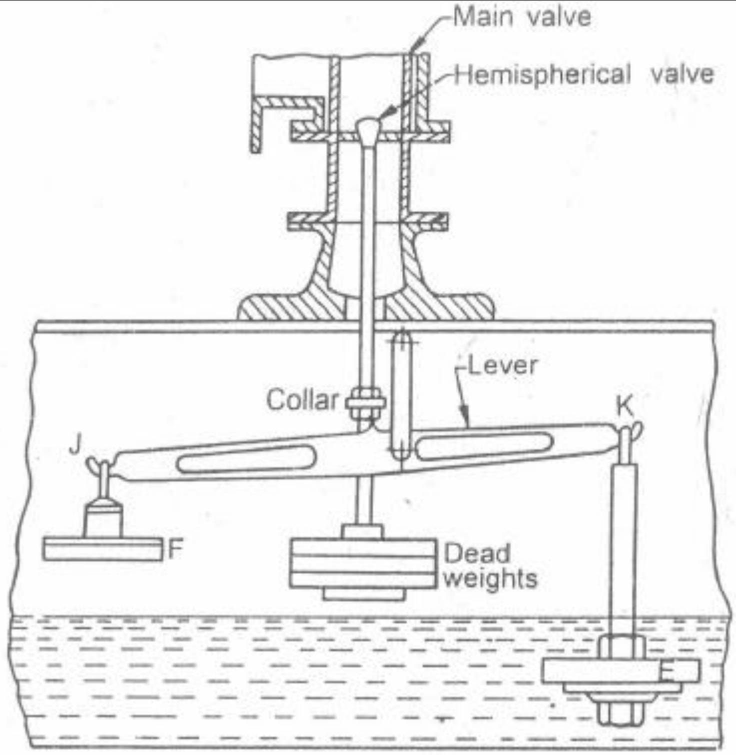
	 • Working: Reaction of anodes $2H_2 \longrightarrow 4H^+ + 4e^-$ Reaction of cathodes: $4H^+ + 4e^- + O_2 \longrightarrow H_2O$ Overall reaction: $2H_2 + O_2 \longrightarrow H_2O$ H_2 fed at anode is split to produces H^+ ions and electones.Electrones flow from the anode to the cathode through an electrical load (electric motor to drive the vehicle) Hydrogen ions flowing from anodes to cathode through electrolyte completes the circuit. O_2fed to the cathode combines with H^+ ions and e^- to produce water. Fuel cell vehicles have similar all improve performance as compared to I.C.engine vehicles • Advantages: Fuel cell vehicles emit heat and water vapour only .so there pulley zero emition vehicles • Disadvantages: they cost 20 times more than conventional vehicles	2m dia. 2m expl.	
b)	Enthalpy It is defined as, "sum of internal energy (U) and product of pressure and volume". Mathematically, H = U + PV Enthalpy of a fluid is a property of fluid, since it consists of sum of a property(U) and product of two other properties (P & V). Unit of enthalpy is kJ / kg . Entropy It is defined as, "a thermodynamic property of a working substance, which increases with addition of heat and decreases with removal of heat". Entropy increase is small, when heat is added at high temperature and is greater, when heat is added at low temperature. Entropy is a property of system i.e. dependent on initial and final states of system and is independentof path followed. It is a function of a quantity of heat, which shows the possibility of conversion of heat into work. In short, entropy is referred as rate of change	2 2	4

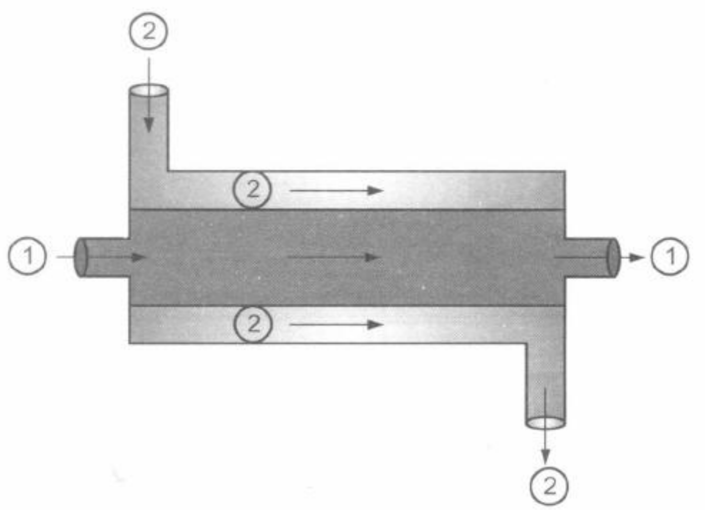
	of heat with respect to absolute temperature. It is defined by symbol'S'. Unit of entropy is kJ / kg K.		
c)	Given data :- $m = 1$ Kg $P = 4$ bar, $x = 0.75$ From steam table, corresponding to press. 4 bar, $h_f = 604.7$ KJ/Kg $h_{fg} = 2132.9$ KJ/Kg $h_g = 2737.6$ KJ/Kg	1	4
	i) Initial heat present in wet steam, $h_1 = h_f + x \cdot h_{fg}$ $h_1 = 604.7 + 0.75 \times 2132.9$ $h_1 = 2204.37$ KJ/Kg	1	
	ii) Final heat of dry saturated steam, $h_2 = h_g$ $h_2 = 2737.6$ KJ/Kg	1	
	Actual quantity of heat to be supplied to make it dry saturated, $h = h_2 - h_1 = 2737.6 - 2204.37$ $\boxed{h = 533.23 \text{ KJ/Kg}}$	1	
d)	(see table below)	1m for each (any four)	4

Sr.No.	Jet Condenser	Surface Condenser
1.	Cooling water and steam are mixed up.	Cooling water and steam do not mix up.
2.	Less suitable for high capacity plants.	More suitable for high capacity plants.
3.	Low initial cost.	High initial cost.
4.	Condensate is washed.	Condensate is reused.
5.	Low maintenance cost.	High maintenance cost.
6.	Requires less quantity of cold	Requires more quantity of

	<table><tr><td></td><td>water.</td><td>cold water.</td></tr><tr><td>7.</td><td>More power is required for air pump.</td><td>Less power is required for air pump.</td></tr><tr><td>8.</td><td>The condensing plant is simple toconstruct.</td><td>The condensing plant is complicated toconstruct.</td></tr></table>		
e)	Concerning an IC engine, as you climb higher altitude the air density decreases. The decrease of air density leads to a higher intake of fuel which in turn leads to a non optimumstoichiometric fuel to air ratio (14:1 being optimum), decreasing performance and making the engine more prone to misfiring with the mixture being too rich (with fuel) if the mixture is not adjusted. it is overcome by using a turbocharger or a supercharger to increase air pressure of intake.	3 1	4
f)	Heat exchangers can be classified as follows: 1. According to nature of heat exchange process: (i) Direct contact type (ii) Indirect contact type: It is further classified as: (a) Recuperators (b) Regenerators 2. According to relative direction of fluid motion (i) Parallel flow (ii) Counter flow (iii) Cross-flow 3. According to design and constructional features (i) Concentric tubes (ii) Shell and tube (iii) Multiple shell and Tube passes 	3m classi. 1m dia.	4
3	**Attempt any four**		**4 x 4=16**

a)	Geothermal Energy: Geothermal energy is the thermal energy trapped below the crust of the earth. 1.In geothermal powerplant steam from underground steam strorage is brought to earths's surface throughdrilled wells and taken to separator,where mostof sand,dust and moisture is separated. 2.This steam drives the turbine which operates the generator producing electricity. 	2m expl. 2m dia.	4
b)	Thermdynamic Property: Any observable characteristic of system is knows as property. The basic properties of system are volume,temperature,pressure etc. There are further dividedinto: 1.Intensive Property 2.Extensive property 1.IntensiveProperty:The properties which donot depend upon the mass of system are known as intenstive properties. e.g. Preessure,Temperature,Specific volume 2.Extensiveproperty:The properties which depend on the mass of the system are known as extensive properties. e.g.Volumeand energy	2 1 1	4
c)	Low Water Safety Valve		4

	 A best known combination of high steam low water safety valve is shown in Fig. It consists of a main valve (known as lever safety valve) and rests on its seat. In the centre of the main valve, a seat for a hemispherical valve is formed for low water operation. This valve is loaded directly by the dead weights attached to the valve by a long rod. There is a lever J-K, which has its fulcrumat K. The lever has a weight E suspended at the end K. When it is fully immersed in water, it is balanced by a weight F at the other end J of the lever When the water level falls, the weight E comes out of water and the weight F will not be sufficient to balance weight E. Therefore weight E comes down, There are two projections on the lever to the left of the fulcrum which comes in contact with a collar attached to the rod. When weight E comes down, the hemispherical valve ,is lifted up and the steam escapes with a loud noise, which warns the operator. A drain pipe is provided to carry water, which is deposited in the valve casing.	2m dia. 2m expl.	
d)	A steam nozzle is a passage of varying cross-section which converts heat energy of steam into kinetic energy. The increase of velocity of steam jet at exit of nozzle is obtained due to decrease in total enthalpy steam. Application of stem nozzle in power engineering: 1. Jet propulsion 2. Turbo-machines 3. Flow measurement 4. Injectors 5. Spray painting.	1m 3m (any three)	4

	6. Ejector condensers.		
e)	Pre-ignition:- The ignition of fuel in an internal-combustion engine before the spark passes through the fuel, resulting from a hot spot in the cylinder or from too great a compression ratio for the fuel. Ignition of the charge in an internal-combustion engine earlier in the cycle than is compatible with proper operation. Pre-ignition occursdue to following reasons: 1) High compression ratio 2) Overheated spark plug point 3) Incandescent carbon deposit in cylinder wall 4) Overheated exhaust valve 5) It may occur due to faulty timing of spark production.	2 2	4
f)	Parallel flow type: • In this type, both the fluids flow in the same direction as shown in figure. • The arran ement is known as arallel flow tear co-current type.  Applications of heat exchanger: (a) Dairy industry. (b) Food industries. (c) Refrigeration and air-conditioning. (d)Steaam and gas turbine power plant. (e) Internal combustion engines. (f) Milk chiller of pasteruzing plant.	2m expl. 2m appli.	4
4	**Attempt any four**		**4 x 4=16**

<table>
<tr><td>a</td><td>Zeroth law of thermodynamics
• When two bodies having different temperature are brought in contact with each other, after some time, both bodies attain same temperature. When this state of equal temperature is attained, then the bodies are said to be in thermal equilibrium.
• Take three bodies namely A, Band C. Suppose A and C are in thermal equilibrium. Similarly let Band C are also in thermal equilibrium, then Zeroth's law states that bodies A and B are also in thermal equilibrium.
• Thus, according to Zeroth's law, if two systems are each in thermal equilibrium with a third system, then the two systems are also said to be in thermal equilibrium with each other.

</td><td>4</td><td>4</td></tr>
<tr><td>b</td><td>Dryness fraction or quality of wet steam.
It is the ratio of tfle mass of actual dry steam, to the mass of same quantity of wet steam, and is generally denoted by 'x'.

Mathematically,
x = mg/(mg +mf)

Where mg = Mass of actual dry steam,
mf = Mass of water in suspension, and

The dryness fraction for dry steam (x) is 1</td><td>3

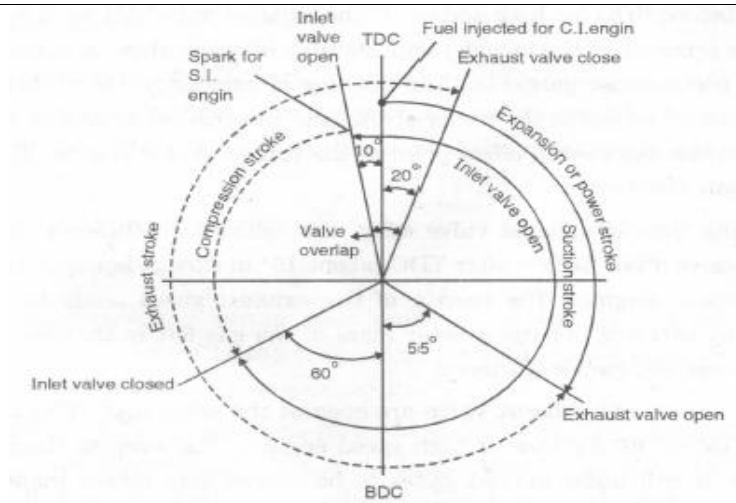
1</td><td>4</td></tr>
<tr><td>c</td><td>Function of boiler mountings:
1.To indicate the water level inside the boiler.
2.To indicate steam pressure insider the boiler.
3.To maintain and safe pressure.

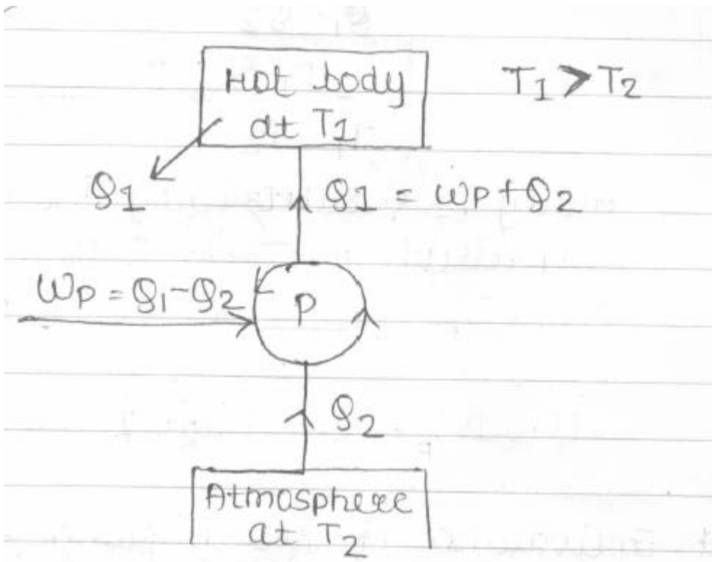
Boiler cannot work without mounting.</td><td>3

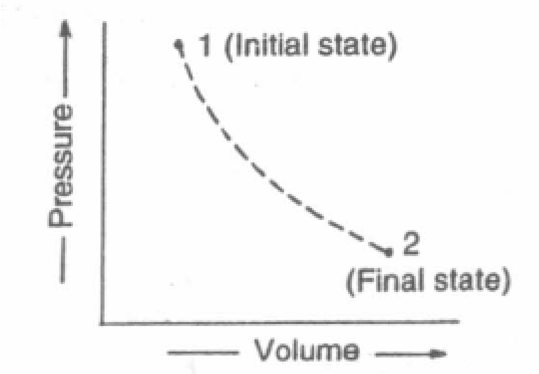
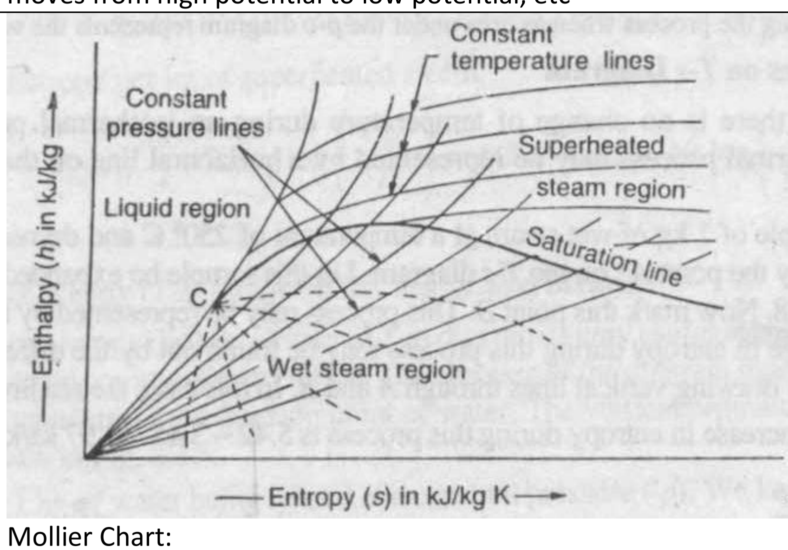
1</td><td></td></tr>
<tr><td>d</td><td><table>
<tr><td>S.No</td><td>Impulse turbine</td><td>Reaction turbine</td></tr>
<tr><td>1</td><td>The steam flows through the nozzles andimpinges on the moving blades.</td><td>The steam flows first through guidemechanism and then through the movingblades.</td></tr>
<tr><td>2</td><td>The steam impinges on the buckets with kinetic energy.</td><td>The steam glides over the moving vanes withpressure and kinetic energy .</td></tr>
<tr><td>3</td><td>The steam mayor may not be admitted over the whole</td><td>The steam must be admitted over the whole circumference.</td></tr>
</table></td><td>1m for each (any one)</td><td>4</td></tr>
</table>

		circumference.		
	4	The steam pressure remains constant during its low through the moving blades.	The steam pressure is reduced during its flow through the moving blades	
	5	The relative velocity of steam while gliding over the blades remains constant (assuming no friction).	The relative velocity of steam while glidingover the moving blades increases (assuming nofriction).	
	6	The blades are symmetrical.	The blades are not symmetrical.	
	7	The number of stages required are less for the same power developed.	The number of stages required are more for the same power developed.	

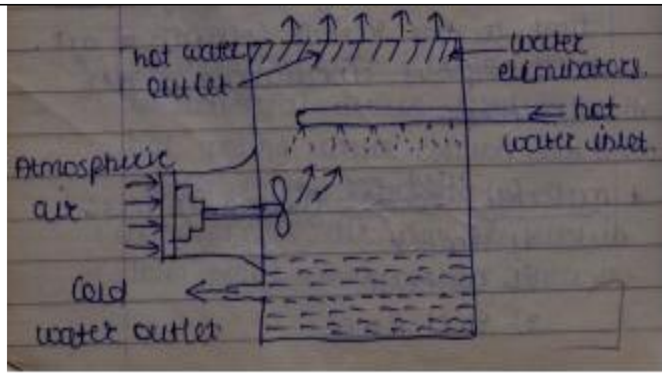
e	i) Vacuum Efficiency: Vacuum efficiency is the ratio of actual vacuum at inlet to condenser to the maximum or ideal vacuum which can be obtained in a perfect condensing plant n_v=Actual vacuum/Ideal vacuum Actual vacuum = barometric pressure- Actual pressure Ideal vacuum=Barometric pressure- Ideal pressure (or pressure corresponding to temperature of condenser) ii) Condenser efficiency: Condenser efficiency is defined as ratio of temperature rise of cooling water to the difference in vacuum temperature and inlet cooling water. n_c=Temperature rise of cooling water/Vacuum temperature inlet cooling water temperature $=t_o-t_i/t_v-t_i$ Where t_o = outlet temperature of cooling water t_i= inlet temperature of cooling water t_v =Vacuum temperature or saturation temperature corresponding to condenser pressure.	2 2	4
f	Valve Timing Diagram for Four Stroke S.I./C.I. Engine:		4

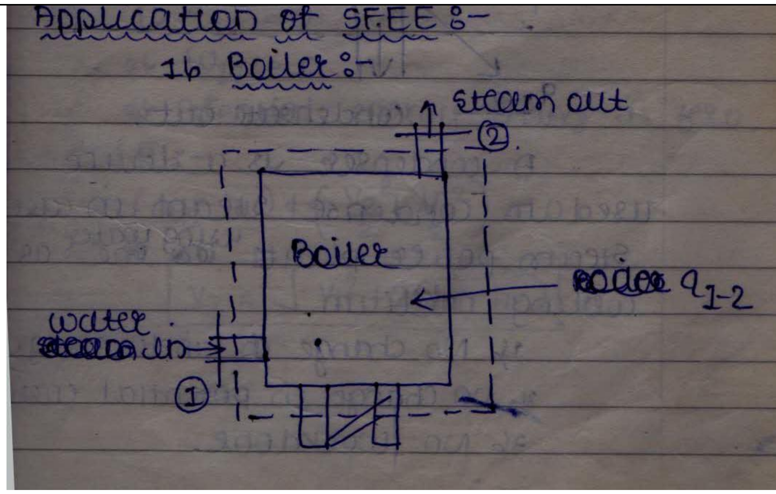
		2m dia.	
	(i) Inlet valve timing: • It bears on the actual quantity of air sucked during suction. i.e. it affects on volumetric efficiency from Fig. The suction valve open 10° before the arrival of piston to TDC on the exhaust stroke. This insure that the valve will be fully open and fresh charge starting to flow into the cylinder as soon as possible after TDC. • When the piston moves BDC and start to move, compression stroke, the inertia ofthe entering fresh charge tend to cause it to continue to move into the cylinder. To take advantage the intake valve closes after BDC. So that max. (air + fuel) charge is taken in. This is called ram effect. • If the intake valve is to remain open for a long time beyond BDC and the intake valve closed at 60° after BDC. At low speed engine inertia is low, the charge speed is low, so the air inertia is low so the intake valve closed early after BDC. (10° after BDC). • There is a limit to the high speed for advantage of ram effect. At very high speeds the effect of fluid friction may be more than 'offset the ramming effect and the charge for cylinder fall off. (ii) Exhaust valve timing: • The exhaust valve is s.et to open before BDC (about 25° before BDC, in low speed '. and 55° before BDC fo.r high speed) ..If the exhaust valve did not start open until BDC, the pressure in the cylinder considerably increase above atmosphere required to expel the exhaust gases, but the opening of exhaust valve earlier reduces the pressure near the end of the power stroke and thus causes some loss of useful work on this stroke, the overall effect prior to the time of piston reaches BDC results in overall gain in output. • The closing time of exhaust valve effect the volumetric efficiency. By closing the exhaust valve a few degree after TDC (about 15° in case of low speed or 20° in case of high speed engine). The inertia of the exhaust gases tends to scavenge the cylinder by carrying out the greater mass of the gas left in the clearance volume. This increase volumetric efficiency. • Both the intake and exhaust valve are open at the same time. This is	2m expl.	

	called valve overlap (15° or 30° for slow or high speed engine). This overlap should not exceed otherwise it will allow burned gases to be sucked into intake manifold or freshcharge to escape through the exhaust valve.		
5	**Attempt any four**		**4 x 4=16**
a	Heat Pump:  It is a device which operating in acyclic process maintains the temperature of a hot body(heated space) at a higher temperature than the surrounings.Heat has to besupplied to the hot body at the same rate at which it is leaking out of the body. (C.O.P)p= Q1 /(Q1-Q2) =T1 / (T1 – T2) Adding and subtracting T2 to the expreesionnumaretor and demometer (C.O.P)p= {T2 / (T1 – T2)} +1 But ,COP of refrigerator is, (C.O.P)R= Desired effect/ Work required =Q2 /(Q1-Q2) =T2 / (T1 – T2) ie. (C.O.P)p=(C.O.P)R +1	1m dia. 2m expl. 1m rela.	4
b	Irreversible process.	4	4

	 If the process takes place in such a manner that the properties at the intermediate states are not in equilibrium state (except the initial and final state), then the process is said to be non-equilibriumor irreversible process. This process is represented by the broken lines on the property diagram as shown in Fig. The irreversible process is also called the natural process because all the processes occurring in nature are irreversible processes. The natural process occurs due to the finite gradient between the two states of the system. For instance, heat flow between two bodies occurs due to the temperature gradient between the two bodies; this is in fact the natural flow of heat. Similarly, water flows from high level to low level, current moves from high potential to low potential, etc		
c	 Mollier Chart: it is a graphical regrphicalrepresation of the steam table in whichenthaphy is plotted along the y axis and Entropy is along the X axis .The digram is divided into two portions by a line termed as saturatationline.In the lowe (Wet) region the temperature of steam remains constant at a given pressure in the upper (suoerheat)region the temperature of steam increases at the give pressure. The mollier diagram has the following lines; (1) Dry ness fraction line:The dry ness fraction line are drawn only	2m dia. 2m expl.	4

	below saturatuin line .This line represents the condition of wet steam between various value h and s. (2) Constant volume line:Constant volume line are drawn in both the wet and superheated region.This line are straight in the wet region and curved upwards above the saturation curve i.e.superheated region. (3) Consant pressure line: The constant pressure linrs are drawn in both the wet and superheated region.This lines are straight in the wet region andcurved upwards above the saturation curve i.e.superheated region. (4) Constant temperature line(Isothemal line):The isothemal lines are drawns only above the saturation line.This line represents the codition of superheated steam between various values of h and s		
d	Dalton'SLaw of Partial Pressures It states "The pressure of the mixture of air and steam is equal to the sum of the pressures which each constitutent would exert, if it occupied the same space by itself." Mathematically, pressure in the condenser containing mixture of air and steam, Pc=Pa+Ps Pa = Partial pressure of air, and Ps = Partial pressure of steam. Note: In most of the cases, we are required to find partial pressure of air, therefore Dalton's law may also used as: Pa =Pc-Ps	4	4
e	Functions of cooling tower: 1. The function of cooling tower is to cool the water (hot) coming from the condenser by exposing it to the atmospheric air. The water so cooled may be recirculated in the condenser. (a) In a cooling tower, water is made to trickle down drop by drop, so that, it comes in contact with the air moving in opposite direction. (b) As a result of this, some water gets evaporated and is taken away with air. (c) In evaporation, the heat is taken away from the bulk of water, which is thus cooled. 2. In case of shortfall, the water from cooling tower is also used as feed water for steam turbine power plant. Forced Draft cooling tower: In this the fan is placed at the bottom of the tower to produce circulation of air . The hot water which is coming from condenser is sprinkled from top and cold water is taken from bottom to circulate in the condenser	2m fun. 1m expl.	4

		1m dia.	
f	SuperCharging: - It is the process of increasing the mass of air -fuel mixture or air induced into the engine cylinder.This is done with the help of compressor or blower known as supercharger. Necessary of supercharging in the engine:- 1) To increase the power output of an engme when greater powe-r IS required. 2) To reduce mass of the engine per brake power. 3) To reduce space occupied by the engine. 4) To reduce the consumption of lubricating oil. 5) To maintain power of aircraft engine at high altitudes where less oxygen is available for combustion.	2 2	4
6	**Attempt any Two**		**2x 8=16**
a	SFEE: $h_1+V_1^2/2+gZ_1+q_{12}= h_2+V_2^2/2+gZ_2+W_{12}$ where, h_1,h_2=enthalpyinlet,outlet v_1,v_2=velocity, inlet,outlet z_1,z_2=Height above datum inlet,outlet, q_{12}=Height transfer W_{12}=work transfer i)For boiler	2m equ. $1\ ^1/_2$	8



It is a device which supplies heat to water and generates steam.

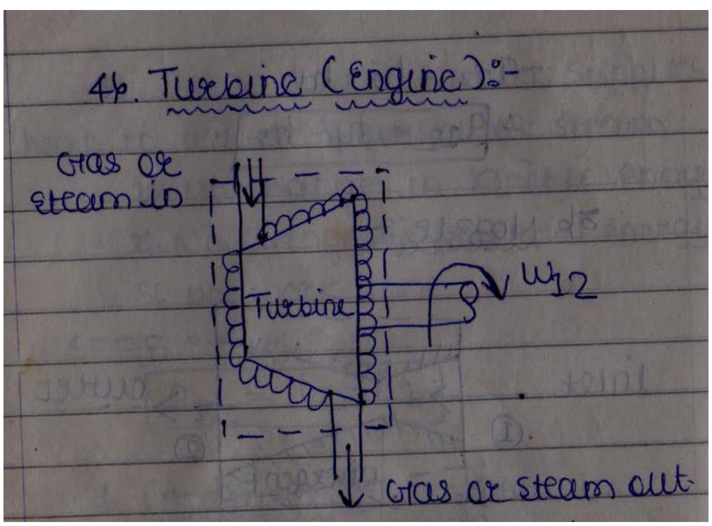
1) No change in kinetic energy
2) No change in potential energy
3) No work done.

SFEE

$q_{12}=h_2-h_1$

ii)Turbine:

1 $^1/_2$

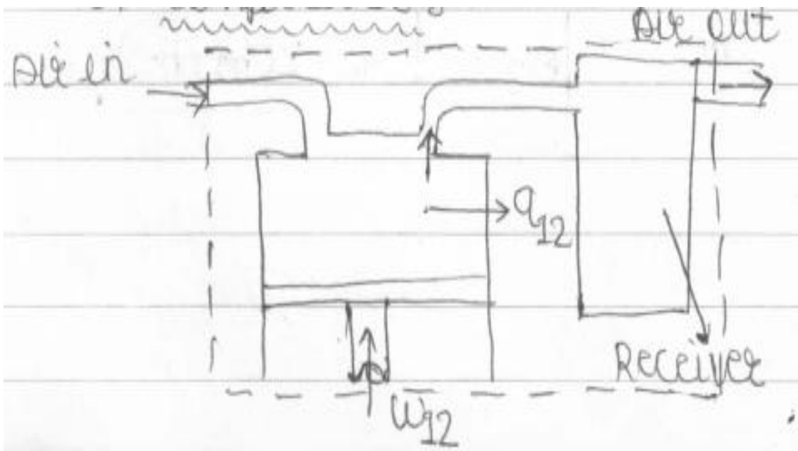
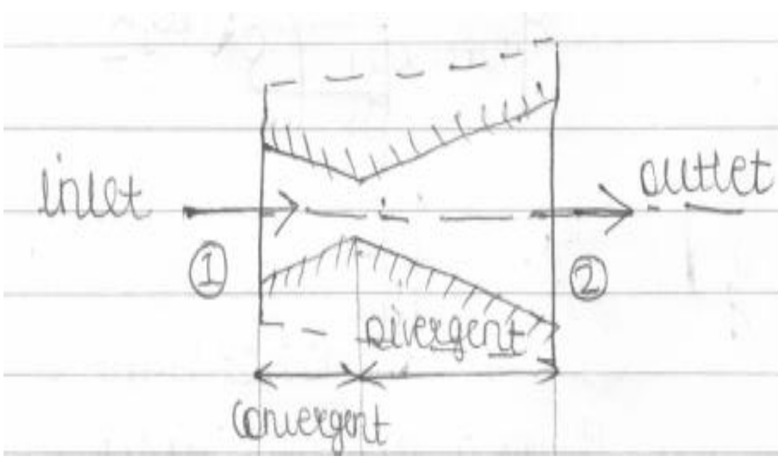


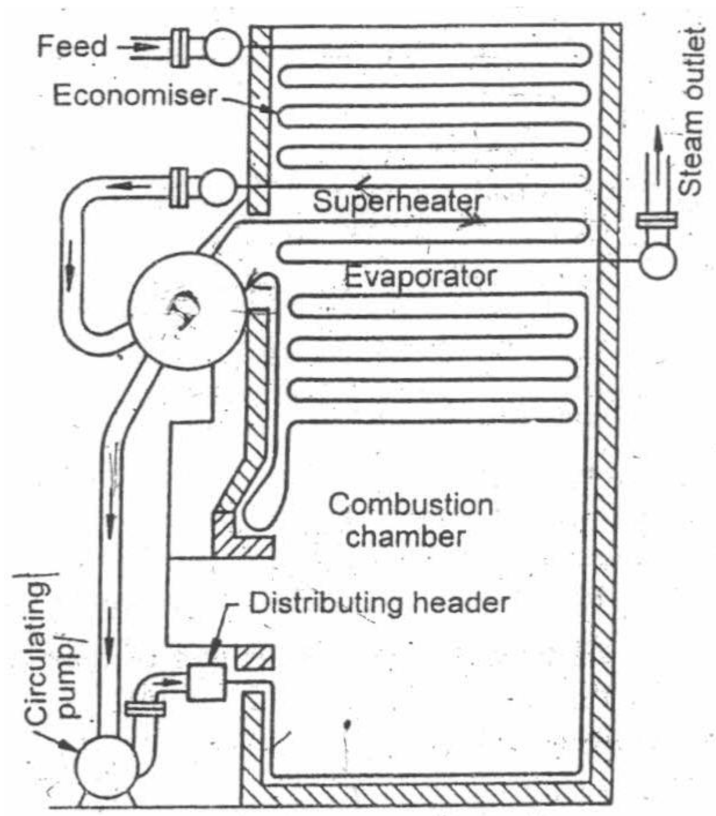
It is devices which convert energy of working substance into a work. The turbine is insulated so.

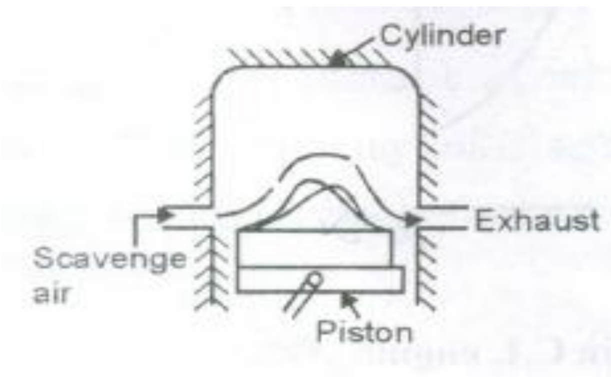
1) $Q_{12} = 0$
2) No change in kinetic energy
3) No change in potential energy

SFEE:

$W_{12}= h_2-h_1$

	iii)Compressor  It is a devicewhich compresses air an supplies the same at which high pressures 1.No change in kinetic energy 2.Nochnge in potential energy. SFEE; $-q_{12}-(-w_{12})=(h_2-h_1)$ $W_{12}= q_{12} + (h_2-h_1)$ iv)Nozzle  It is a a device which increses the velocity of working substance,the nozzle insulated so that no het transfer take place. 1.q_{12} = 0	$1\ ^1/_2$ $1\ ^1/_2$	

	2.$w_{12} = 0$ 3.Potential energy change is zero. SFEE; $(h2-h1) + \{(v_2^2)/2 - (v_1^2)/2)\} = 0$ $v_2 = \sqrt{\{v_1^2 + 2(h_1-h_2)\}}$		
b	La-Mont Boiler  This is a modem high pressure water tube steam boiler working on a forcedcirculation. The circulcrtion is maintained by a centrifugal pump,driven 'by a steam turbine, using steam from the boiler. The forced circulation causes the feed water to circulate through the Water walls and drums equal to ten timesthe mass of steam evaporated. This prevents the tubes from being overheated. A diagrammatic sketch of La-Mont steam, boiler is shown in Fig.The feed water passes through the economiser to an evaporating drum.It is then drawn to the circulating pump through the tube. The pump delivers the feed to the headers, at a pressureabove the drum pressure; The header distributes water through nozzles into the generating tubes acting in parallel. The water and steam from these tubes passes into the drum, The steam in the drum is then drawn through the superheater.	4m dia. 4m expl.	8

c	Scavenging: • The clearing or sweeping out of the exhaust gases from the combustion chamber of the cylinder is known as scavenging. • It is necessary that- cylinder should not have any burnt gases because they mixed with the fresh incoming charge and reduce its strength. Power will lost if the fresh charge is diluted by the exhaust gases. • The scavenging is necessary only in two stroke engine since piston does not help forclearing the burned gas from the cylinder. The scavenging methods in two stroke cycle engine are : (a) Cross flow scavenging: (b) Full-loop or backflow scavenging (c)Uniform flow scavenging: a)The Cross flow scavenging method  • The admission ports are provided on the sides of the cylinder and exhaust ports are kept on the opposite cylinder wall. • The charge or air entering through the scavenge (admission) ports is directed upward which pushes out the exhaust gases through oppositely situated exhaust ports as shown in Fig.	3m 2m for method 1m dia. 2m expl.	8