WINTER – 14 EXAMINATIONS

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

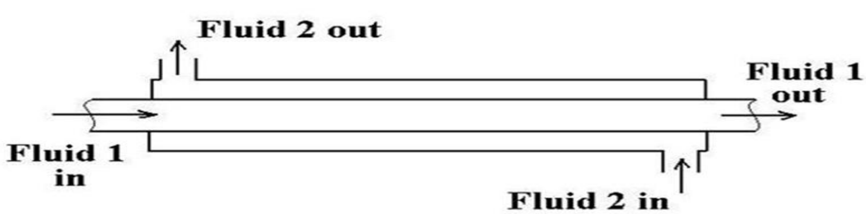
Important Instructions to examiners:

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 A	Attempt any three		12
a)	(see table below)	4 (any 4)	4

SR NO	RENEWABLE ENERGY SOURCES	NONRENEWABLE ENERGY SOURCES
1	the resources that can be renewed by reproduction are called renewable resources.	the resources that are present in fixed quantities are called non-renewable resources.
2	Renewable resources are inexhaustible.	Non-renewable resources are inexhaustible.
3	Renewable resources are not affected by the human activities.	Non renewable resources are affected by human activities.
4	All biotic resources are renewable.	Some abiotic resources are non-renewable.
5	Clean source of energy	They will emit pollutants
6	Cost is much therefore not used much	Cost is less therefore preffered
7	Available in the abundant form	Available in the limited form
8	For example: air and water.	For example- fossil fuels and minerals.

Q. NO.	MODEL ANSWER	MARKS	TOTAL MARKS
b)	(diagram below)	2	4

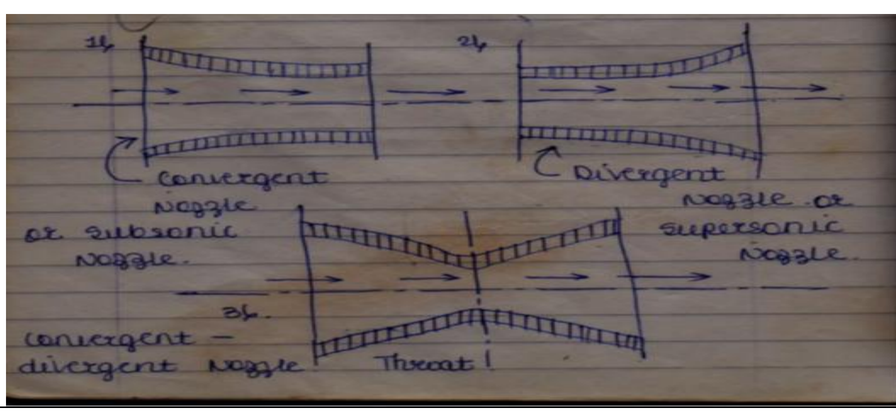


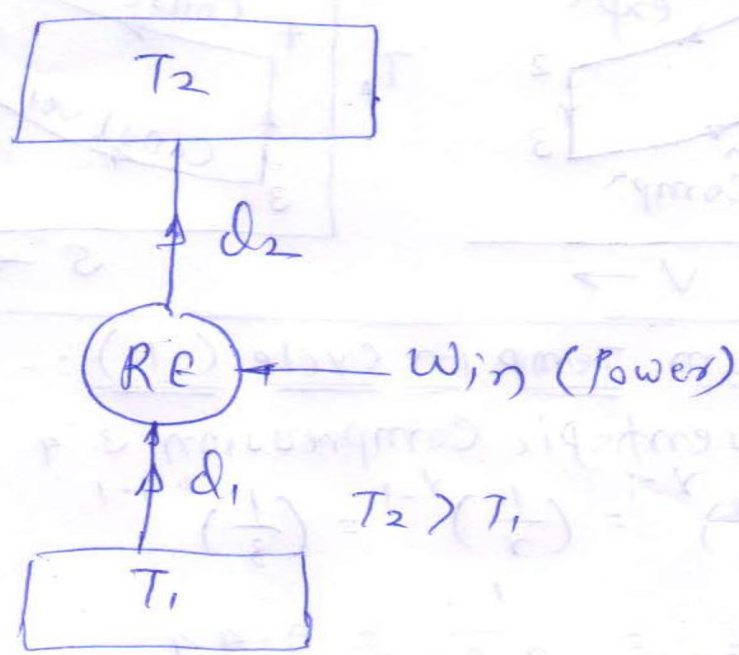
Double Pipe Heat Exchanger Counterflow

Counter flow, as illustrated in Figure 4, exists when the two fluids flow in opposite directions. (2)

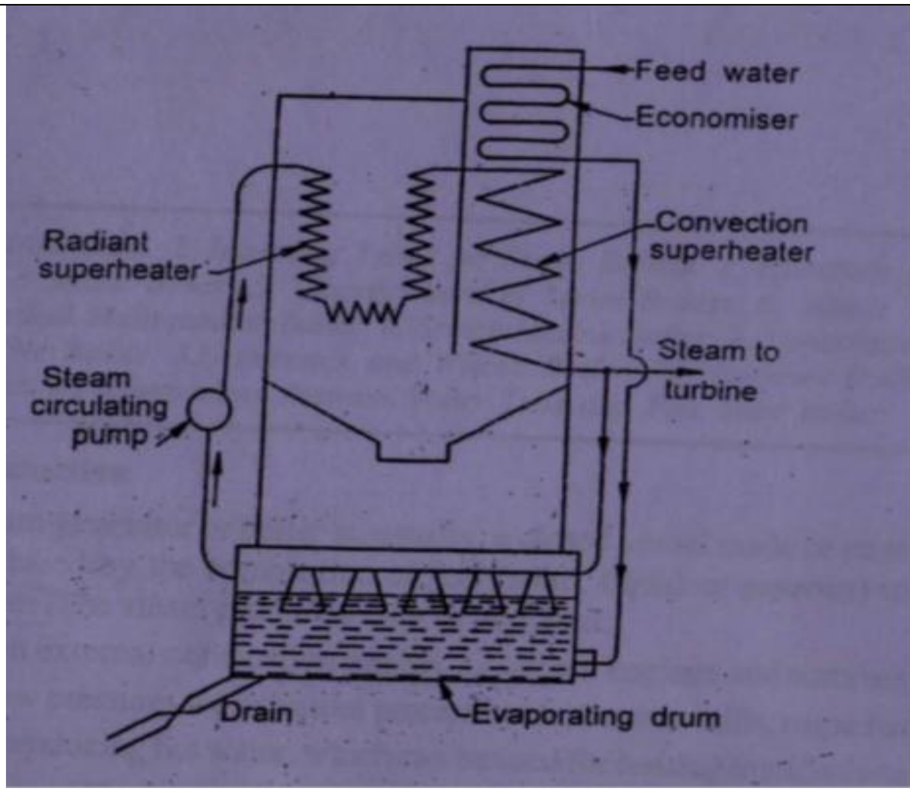
Each of the fluids enters the heat exchanger at opposite ends.

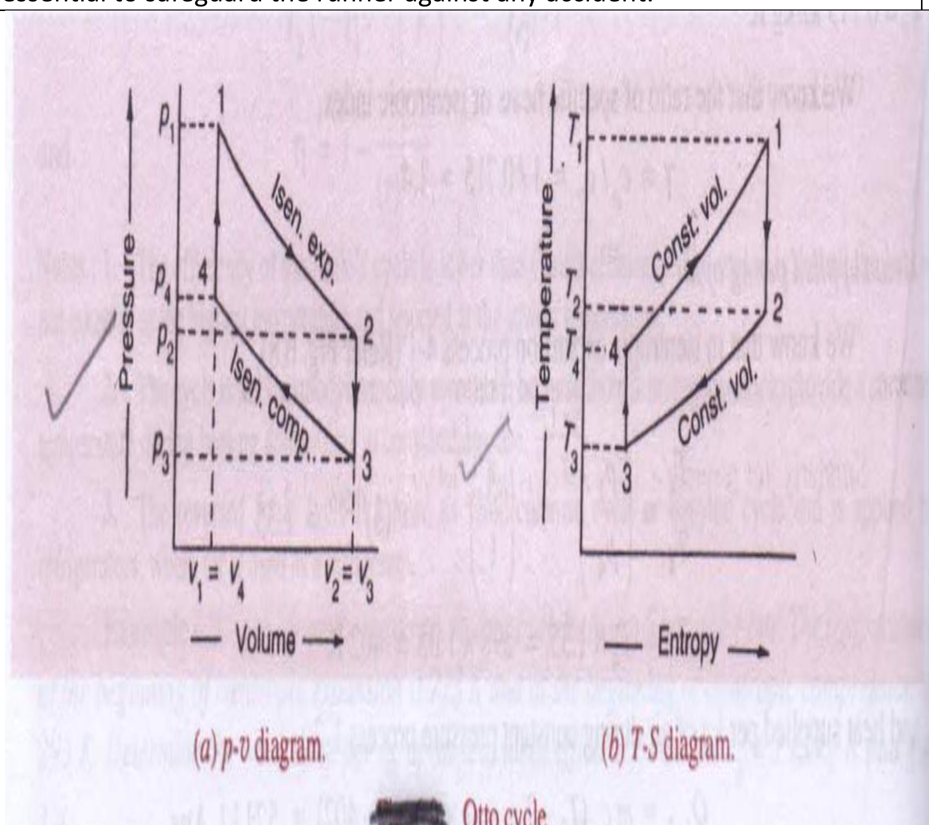
Because the cooler fluid exits the counter flow heat exchanger at the end where the hot fluid enters the heat exchanger, the cooler fluid will

	approach the inlet temperature of the hot fluid. Counter flow heat exchangers are the most efficient of the three types. In contrast to the parallel flow heat exchanger, the counter flow heat exchanger can have the hottest coldfluid temperature greater than the coldest hot-fluid temperatue.		
c)	**Pre-ignition:-** The ignition of fuel in an internal-combustion engine before the spark passes through the fuel, re sulting 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. **Detonation:**- Detonation (generally caused by fuel with a low octane rating) is the tendency for the fuel to pre-ignite or auto-ignite in an engine's combustion chamber. This early (before the spark plug fires) ignition of fuel creates a shock wave throughout the cylinder as the burning and expanding fuel air mixture collides with the piston that is still traveling towards top-dead-center. The resulting knock/ping is the sound of the pistons slamming against the cylinder walls. Severe detonation can break pistons and destroy engines.	2 2	4
d)	TYPES OF STEAM NOZZLES: There are three important types; 1. Convergent nozzie. 2. Divergent nozzle. 3. Convergent - divergent nozzle Types of Steam Nozzles If the cross section of the nozzle decreases continuously from entrance to exit; then it is called convergent nozzle. If the cross section of a nozzle increases continuously from entrance to exit then it is called Divergent nozzle. If the cross section of a nozzle decreases first up to certain length and then increases up to exit; then it is called - Convergent - Divergent nozzle. This is used mostly in various types of steam turbines 	2 2 (Diag)	4
e)	1.According to the contents in the tube	4	4

	a)Fire tube or smoke tube boiler, and (b) Water tube boiler 2.According to the position of the furnace a) Internally fired boilers, and (b) Externally fired boilers 3.According to the axis of the shell (a) Vertical boilers, and (b) Horizontal boiler 3. According to the number of tubes (a) Single tube boilers, and (b) Multitubular boilers 5. According to the method of circulation of water and steam (a) Natural circulation boilers, and (b) Forced circulation boilers.	(any 4)	
B	**Attempt any one**		**8**
a)			8

	Given Q1 [B] (a) C.O.P = 5.4 kw T_1 = 50 °C Power = 5 kw we know that $C.O.P. = \frac{R.E}{W_{comp}}$ $= \frac{R.E.}{Power}$ $C.O.P. = \frac{T_1}{T_2 - T_1}$ $5.4 = \frac{50}{T_2 - 50}$ $\therefore$ $T_2 = 59.25°C$	4	
	Also we know that $C.O.P = \frac{RE}{Power}$ $5.4 = \frac{R.E}{5}$ R.E = 27 kw	4	

b)	 Brief explanation: Advantages:- 1. Loeffler boiler can carry higher salt concentration than any other type of boiler. 2. Since evaporating tubes of Loeffler boiler carries only superheated steam there is no salt deposition so it is suitable for marine applications 3. Boiler is compact in design	4 (Diagm.) 2 2 (any 2)	8
2	**Attempt any four**		**16**
a)	Impulse Turbine An impulse turbine, as the name indicates, is a turbine which runs by the impulse of steam jet In this turbine, the steam is first made to flow through a nozzle. Then the steam jet impinges on the turbine blades (which are curved like buckets) and are mounted on the circumference of the wheel. The steam jet after impinging glides over the concave surface of the blades and finally leave the turbine. Note: The action of the jet of steam, impinging on the blades, is said to be an impulse and the rotation rotor is due to the impulsive forces of the steam jets. De-Level ImpulseTurbine A De-Level turbine is the simplest type of impulse steam turbine, and is	4	4

	commonly used. It has the following main components : 1. Nozzle. It is a circular guide mechanism,which guides the steam to flow at the designed directionand velocity. It also regulates the flow of steam. The nozzle is kept very close to the blades, in order to minimisethe losses due to windage. 2. Runner and blades. Therunner o f a De-Laval impulse turbine essentially consists of a circular disc fixed to a horizontal shaft.On the periphery of the runner, anumber of blades are fixed uniformly. The steam jet impinges on the buckets, which move in the direction of the jet. This movement of the blades makes the runner to rotate. The surface of the blades is made very smooth to minimise the frictional losses. The blades are generally made of special steel alloys. In most of the cases, the blades are bolted to the runner disc. But sometimes the blades and disc are cast as a single unit. It has been experienced that all the blades do not wear out equally with the time. A few of them get worn out and damaged early and need replacement. This can be done only if the blades are bolted to the disc. 3. Casing. It is an air-tight metallic case, which contains the turbine runner and blades. It controls the movement of steam from the blades to the condenser, and does not permit it to move into the space. Moreover, it is essential to safeguard the runner against any accident.		
b)	 Otto Cycle	2 (Diagm) 2	4

	the first successful engine working on this cycle was built by A. Otto. The ideal Otto cycle consists of two constant volume and two reversible adiabatic or isentropic processes as shown on p-v and T-S diagrams in Fig. (a) and (b). Let the engine cylinder contain m kg of air at point 1.At this point, let P1,T1 and V1be the pressure, temperature and volume of the air. Following are the four stages of the ideal cycle: 1.First stage (Reversible adiabatic or isentropic expansion). The air is expanded reversibly and adiabatically from initial temperature T1 to a temperature T2 as shown by the curve 1-2 in Fig.(a) and (b). In this process, no heat is absorbed or rejected by the air. 2.Second stage (Constant volume cooling). The air is cooled at constant volume from temperature T2 to a temperature T3 as shown by the curve 2-3 in Fig. (a) and (b). We know that heat rejected by the air during this process Q2-3=mCv(T1-T2) 3.Third stage (Reversible adiabatic or isentropic compression). The air is compressed reversibly and adiabatically from temperature T3 to a temperature T4 as shown in by the curve 3-4 in Fig. (a) and (b). In this process, no heat is absorbed or rejected by the air. 4. Fourth stage (Constant volume heating). The air is now heated at constant volume from temperature T4 to a temperature T1as shown by the curve 4-1 in Fig. (a) and (b). We know that heat absorbed by the air during this process, Q4-1 = m Cv (T1 - T4) $\eta = 1-(T3/T4) = 1-(T2/T1) = 1-\{1/[(r)^{\gamma-1}]\}$		
c)	SFEE EQUATION:- **$m(h1 + V1^2/2 + gz1 + q1\text{-}2) = m(h2 + V2^2/2 + gz2 + w1\text{-}2)$** P1 = Pressure of the working substance entering the system in N/m^2, Vs1 = Specific volume of the working substance entering the system in m^3/kg. VI1= Velocity of the working substance entering the system in m/s, u1 = Specific internal energy of the working substance entering the system in J/kg, z1= Height above datum level for inlet in metres, P2, Vs2, V2, u2 and z2 = Corresponding values for the working substance leaving the system. q1-2 = Heat supplied to the system in J/kg and w1-2 = Work delivered by the system in J/kg	1 3	4

d)	p_1 = Pressure of steam before throttling, *i.e.* pressure of steam main, p_2 = Pressure of steam after throttling, h_{f1} = Sensible heat of water at pressure p_1, . . . (From steam tables) h_{fg1} = Latent heat of steam at pressure p_1, . . . (From steam tables) h_{g2} = Total heat of dry steam at pressure p_2, . . . (From steam tables) t_{sup} = Temperature of superheated steam after throttling, t_2 = Saturation temperature at pressure p_2, . . . (From steam tables) c_p = Specific heat of superheated steam, and x = Dryness fraction of steam before throttling.	2 (Diagm.)	4

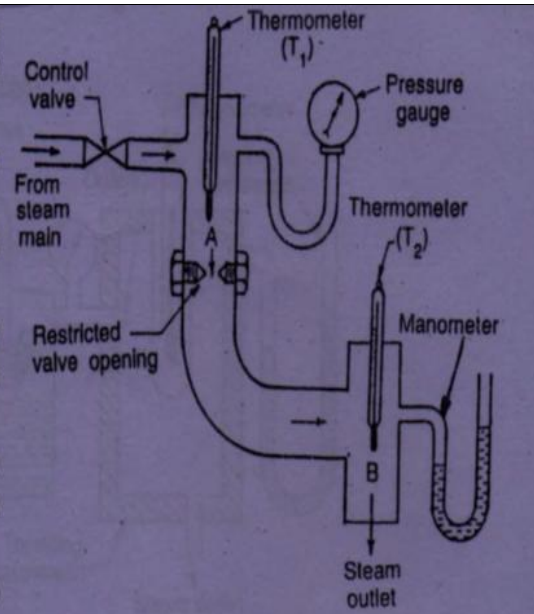


Fig. 7.5. Throttling calorimeter.

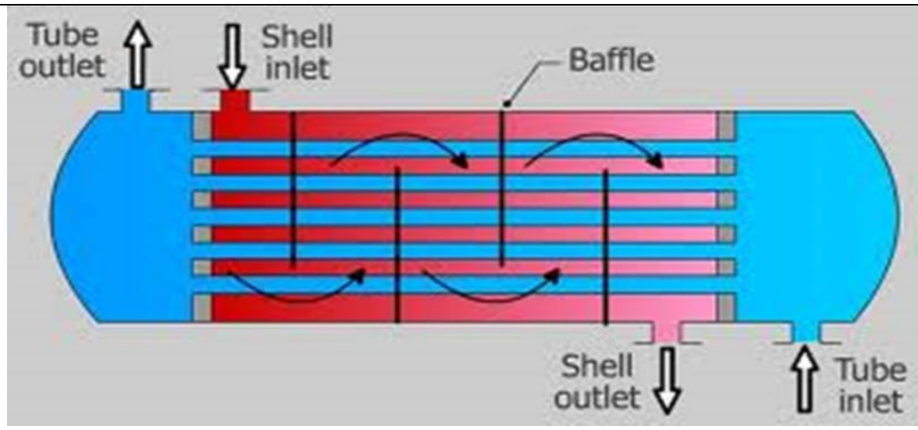
Working:- (2)

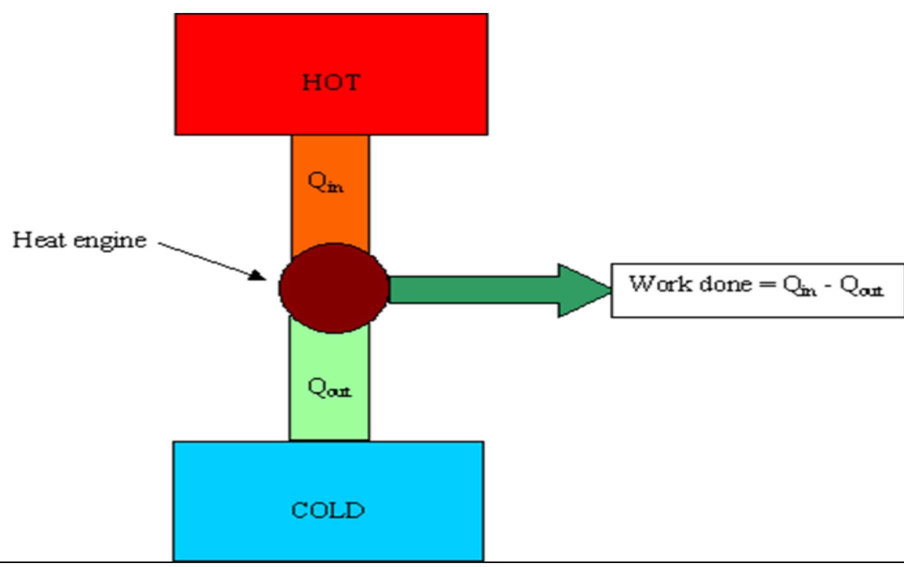
A throttling calorimeter used to determine the dryness fraction of steam is shown in fig. It consists of a separator A into which steam is admitted through a control valve from the steam main. The pressure and temperature are measured by the pressure gauges and thermometer T_1 provided in this section .It may be noted that temperature recorded by T_1 is same as the saturation temperature corresponding to the pressure of steam in calorimeter B .This steam is then throttled through a narrow aperture of restricted valve opening, its total heat remaining constant. The steam is the superheated state after throttling at a lower pressure than previous. The temperature and pressure of steam leaving the calorimeter B is noted by the thermometer T_2 and manometer respectively.

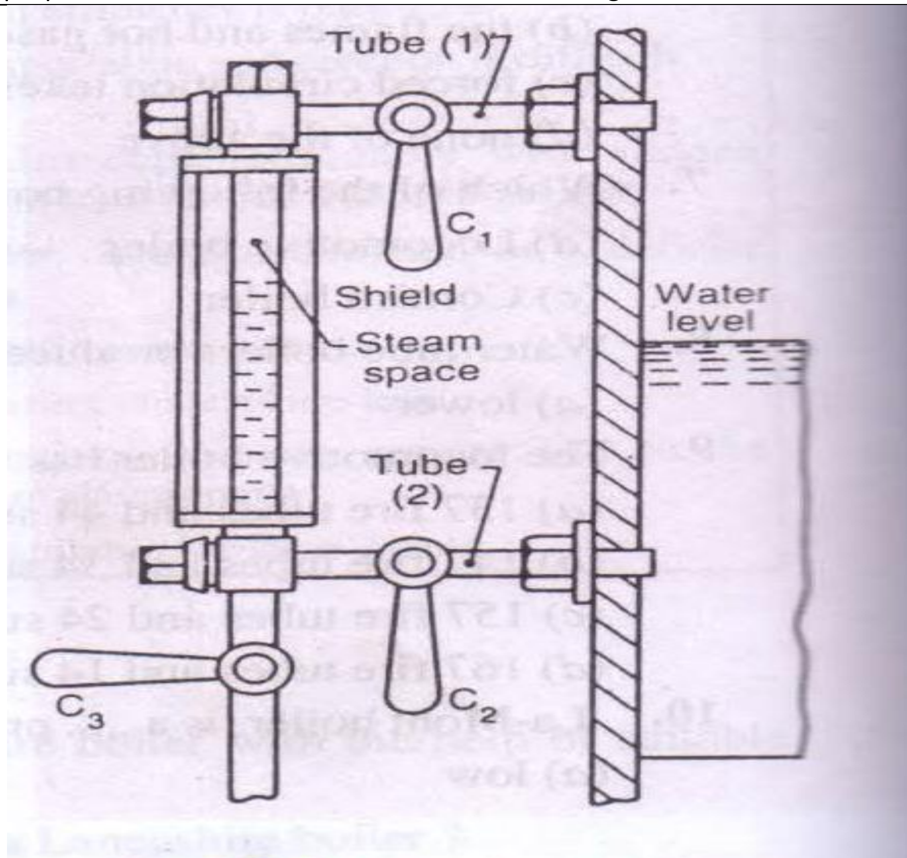
Since the stream has undergone a throttling process, therefore

Total heat before throttling = Total heat after throttling

$H_{f1}+xh_{fg1} = h_{g2}+c_p(t_{sup}-t)$

e)	 **Working:-** A shell and tube heat exchanger is a class of heat exchanger designs. It is the most common type of heat exchanger in oil refineries and other large chemical processes, and is suited for higher-pressure applications. As its name implies, this type of heat exchanger consists of a shell (a large pressure vessel) with a bundle of tubes inside it. One fluid runs through the tubes, and another fluid flows over the tubes (through the shell) to transfer heat between the two fluids. The set of tubes is called a tube bundle, and may be composed of several types of tubes: plain, longitudinally finned, etc. Two fluids, of different starting temperatures, flow through the heat exchanger. One flows through the tubes (the tube side) and the other flows outside the tubes but inside the shell (the shell side). Heat is transferred from one fluid to the other through the tube walls, either from tube side to shell side or vice versa. The fluids can be either liquids or gases on either the shell or the tube side. In order to transfer heat efficiently, a large heat transfer area should be used, leading to the use of many tubes. In this way, waste heat can be put to use. This is an efficient way to conserve energy.	2 (Diagm.) 2	4
f)	**Condenser efficiency** The condenser efficiency may be defined as the ratio of temperature rise of cooling water to the vacuum temperature minus inlet cooling water temperature. Mathematically, condenser efficiency ɳ = Temperature rise of cooling water / Vacuum temperature - Inlet cooling water temperature = to-ti /tv-ti Where to = Outlet temperature of cooling water. ti = Inlet temperature of cooling water. tv = Vacuum temperature. It is the saturation temperature corresponding to the condenser pressure **Vacuum Efficiency** The minimum absolute pressure (also called ideal pressure) at the steam inlet of a condenser is the pressure corresponding to the temperature of	2 2	4

	the condensed steam. The corresponding vacuum (called ideal vacuum) is the maximum vacuum that can be obtained in a condensing plant. with no air present at that temperature. The pressure in the actual condenser is greater than the ideal pressure by an amount equal to the pressure of air present in the condenser. The ratio of the actual vacuum to the ideal vacuum is known as vacuum efficiency. Mathematically, vacuum efficiency, ηc= Actual vacuum / Ideal vacuum . where Actual vacuum = Barometric pressure - Actual pressure and Ideal vacuum = Barometric pressure - Ideal pressure		
3	**Attempt any four**		**16**
a i)	**Pure substance:-** A pure substance or chemical substance is a material that has constant composition (is homogeneous) and has consistent properties throughout the sample. Here are examples of pure substances. Pure substances exhibit very well-defined physical properties, or properties that are not connected with the substance's ability to combine with different substances. The temperatures where pure solids melt, known as melting points, are particularly sharp, meaning the melting occurs at a single temperature. Likewise, the temperatures where pure liquids begin to boil, or boiling points, occur at single temperatures when other factors like air pressure are controlled. Examples: water, diamond, gold, table salt (sodium chloride), ethanol	2	4
ii)	**Heat Engine:-** In thermodynamics, a heat engine is a system that converts heat or thermal energy to mechanical energy, which can then be used to do mechanical work. It does this by bringing a working substance from a higher state temperature to a lower state temperature  	2	
b)	**Intensive Properties:-**	2	4

	An intensive property is a bulk property, meaning that it is a physical property of a system that does not depend on the system size or the amount of material in the system. Examples of intensive properties include temperature, refractive index, density, and hardness of an object. **Extensive Properties:-** By contrast, an extensive property is one that is additive for independent, noninteracting subsystems. The property is proportional to the amount of material in the system. For example, both the mass and the volume of a diamond are directly proportional to the amount that is left after cutting it from the raw mineral	2	
c)	 Water level indicator. **Water LevelIndicator** It is an important fitting, which indicates the water level inside the boiler to an observer. It is a safety device, upon which the correct working of the boiler depends. This fitting may be seen in front of the boiler, and are generally two in number.A water level indicator, mostly employed in the steam boiler is shown in Fig. . It consists of three cocks and a glass tube. Steam cock C1 keeps the glass tube in connection with the steam space.	2 (Diagm.) 2	4

	Water cock C2 puts the glass tube in connection with the water in the boiler. Drain cock C3 is used at frequent intervals to ascertain that the steam and water cocks are clear. In the working of a steam boiler and for the proper functioning of the water level indicator, the steam and water cocks are opened and the drain cock is closed. In this case,the handles are placed in a vertical position as shown in Fig. The rectangular passage at the ends of the glass tube contains two balls.In case the glass tube is broken, the two balls are carried along its passages to the ends of theglass tube. It is thus obvious, that water and steam will not escape out. The glass tube can be easily replaced by closing the steam and water cocks and opening the drain cock.		
d)	(see table below)	4 (any 4)	4

S.No	Impulse turbine	Reaction turbine
1	The steam flows through the nozzles andimpinges on the moving blades.	The steam flows first through guide mechanism and then through the moving blades.
2	The steam impinges on the buckets with kinetic energy.	The steam glides over the moving vanes with pressure and kinetic energy .
3	The steam mayor may not be admitted over the whole circumference.	The steam must be admitted over the whole 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 gliding over the moving blades increases (assuming no friction).
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	(see table below)	4 (any 4)	4

Sr no	Two Stroke	Four Stroke
1	The two-stroke engine completes one cycle of events for every revolution of the crankshaft	completes one cycle of events with the two revolutions required for the four-stroke engine cycle.
2	Theoratical power developed is more	Theoratical power developed is less
3	There are fewer working parts in a two-stroke engine	There are more working parts in four-stroke engine.
4	Cheap to manufacture	Expensive to manufacture.
5	Maintenance is less	Maintenance is more.

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<tr><td>6</td><td>Self lubrication by mixing with fuel.</td><td>Separate lubrication is required.</td></tr>
<tr><td>7</td><td>Need of Scavenging</td><td>No need of scavenging.</td></tr>
<tr><td>8</td><td>Operation is smooth.</td><td>Operation is not much smooth.</td></tr>
<tr><td>9</td><td>More Pollution</td><td>Less pollution.</td></tr>
<tr><td>10</td><td>Light in weight</td><td>Heavier than two stroke.</td></tr>
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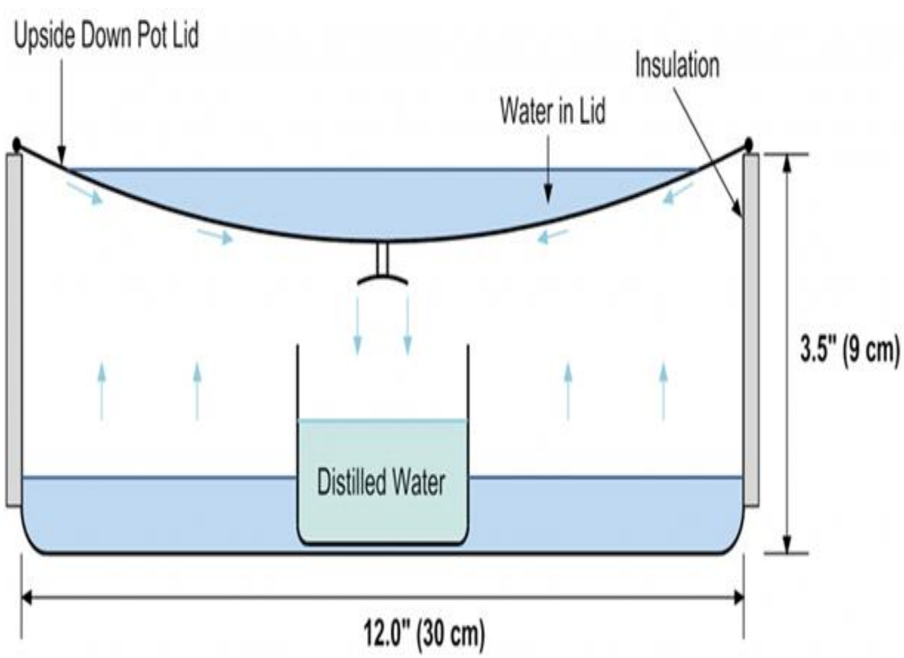
</td><td></td><td></td></tr>
<tr><td>f</td><td>Solar Distillation
The equipment needed for both the solar and fuel based methods is essentially the same, see Figure 1 below. For the solar application, we used a large diameter, relatively shallow pot with a glass cover. The cover was inverted so water condensed on the inside of the cover, ran toward the center of the pot and dripped down into a small cup. Water was added on top of the inverted lid to lower the temperature of the condensing surface and increase the efficiency of the still. The still will produce about 8 oz (200ml) per day.
If a glass covered pot is not available, a simple solar still can be made by placing a black open-topped can inside of a jar as seen in Figure 2. The can is filled with water. Water then evaporates and condenses inside the jar. The lid of the jar should be lightly insulated to prevent water from condensing on the lid and dripping into the open topped can. Sitting this jar on a reflector will increase distillation capacity. With a reflector, about 1 ounce (30 mL) could be produced per day. Production per day will decrease as the can empties. The can should be refilled when it is half empty.

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2
(Diagm.)</td><td>4</td></tr>
<tr><td>4</td><td>Attempt any four</td><td></td><td>16</td></tr>
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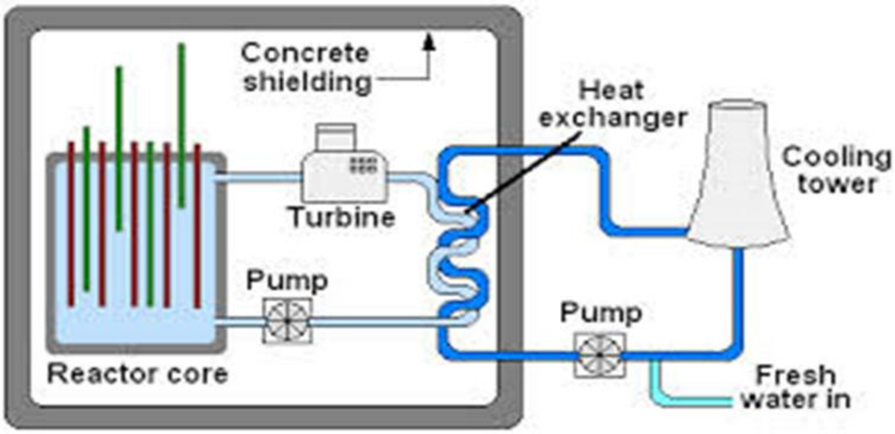
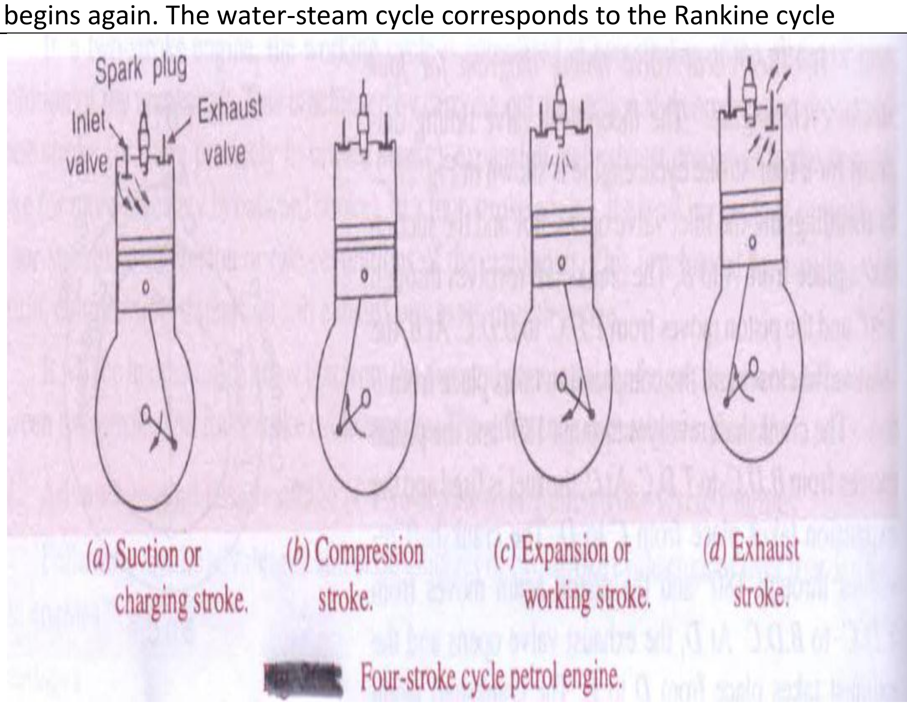
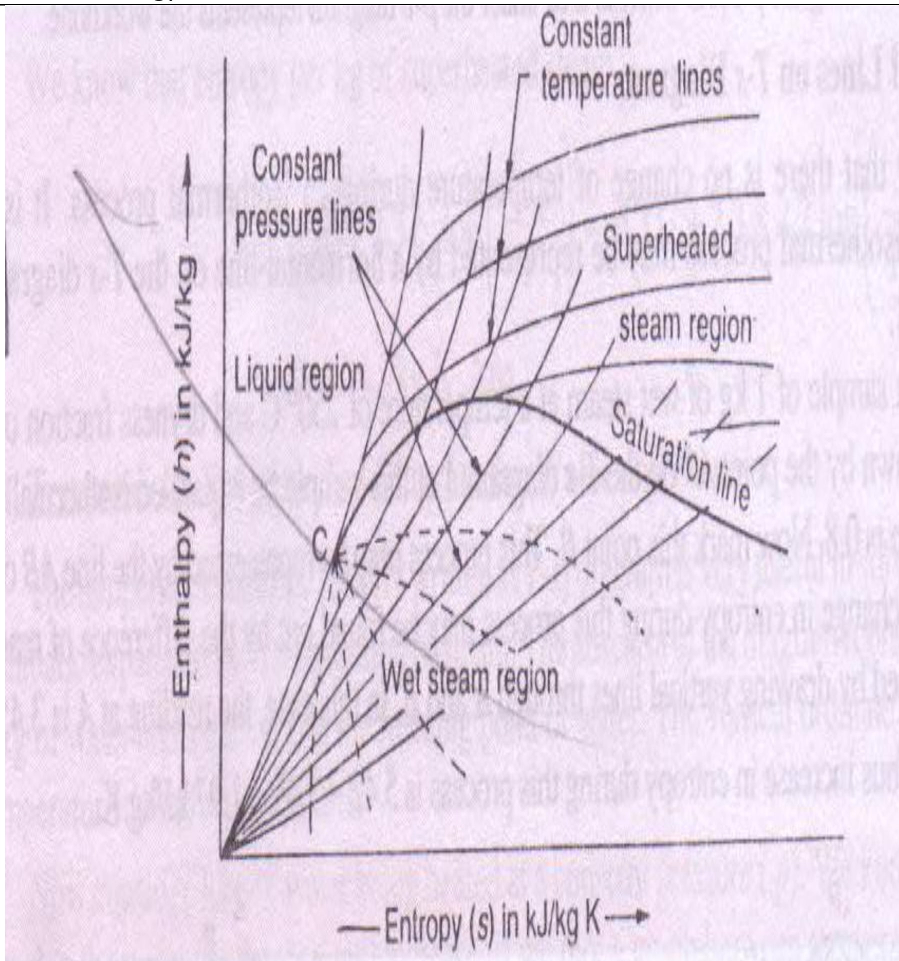
a	 Working:- The conversion to electrical energy takes place indirectly, as in conventional thermal power plants. The heat is produced by fission in a nuclear reactor (a light water reactor). Directly or indirectly, water vapor (steam) is produced. The pressurized steam is then usually fed to a multi-stage steam turbine. Steam turbines in Western nuclear power plants are among the largest steam turbines ever. After the steam turbine has expanded and partially condensed the steam, the remaining vapor is condensed in a condenser. The condenser is a heat exchanger which is connected to a secondary side such as a river or a cooling tower. The water is then pumped back into the nuclear reactor and the cycle begins again. The water-steam cycle corresponds to the Rankine cycle	2 (Diagm.) 2	4
b	 Four-stroke Cycle Petrol Engine	2 (Diagm.) 2	4

	It is also known as Otto cycle. It requires four strokes of the piston to complete one cycle of operation in the engine cylinder. The four strokes of a petrol engine sucking fuel-air nixture (petrol mixed with proportionate quantity of air in the carburettor known as charge) are described below 1. Suction or charging stroke. In this stroke, the inlet valve opens and charge is suckedinto the cylinder as the piston moves downward from top dead centre (T.D.C.). It continues till thepiston reaches its bottom dead centre (B.D.C.) as shown in Fig. (a). 2. Compression stroke. In this stroke, both the inlet and exhaust valves are closed and the charge is compressed as the piston moves upwards fromB.D.C. to T.D.C. As a result of compression the pressure and temperature of the charge increases considerably (the actual values depend upon the compression ratio). This completes one revolution of the crankshaft. The compression stroke is shown in Fig. (b). 3.Expansion or working stroke. Shortly before the piston reaches T.D. C. (during compresssion stroke), the charge is ignited with the help of a spark plug. It suddenly increases the pressure and temperature of the products of combustion but the volume, practically, remains constant. Due to the rise in pressure, the piston is pushed down with a great force. The hot burnt gases expand due to high speed of the piston. During this expansion, some of the heat energy produced is transformed into mechanical work. It may be noted that during this working stroke, as shown in Fig. (c), both the valves are closed and piston moves from T.D.C. to B.D.C.		
c	**First Law of Thermodynamics** This law may be stated as follows: a).The heat and mechanical work are mutually convertible **OR** b) The energy call neither be created nor destroyed though it can be transformed from one to another. According.to this law, when a system undergoes a change of state (or a therrnodymic process), then both heat transfer and work transfer takes place. The net energy transfer is stored within the system and is known as stored energy or total energy of the system. Mathematically $đQ - đw = dE$ **Limitations of First Law of Thermodynamic** 1 When a closed system undergoes a thermodynamic cycle, the net heat transfer is equal to the net work transfer. This statement does not specify the direction of flow of heat and work (i.e.whether the heat flows from a hot body to a cold body or from a cold body to a hot body). It also does not give any condition under which these transfers take place. 2. The heat energy and mechanical work are mutually convertible. Though the mechanical work can be fully converted into heat energy, but only a part of heat energy can be converted into mechanical work. This means that the heat energy and mechanical work are not fully mutually convertible. In other words, there is a limitation on the conversion of one	2 (any statement) 2	4

	form of energy into another form.		
d	 h-s diagram for water and steam. Enthalpy-Entropy (h-s) Diagram for Water and Steam or Mollier Chart It is a graphical representation of the steam tables, in which the enthalpy (h) is plotted.along the ordinate and the entropy (s) along abscissa. First of all, enthalpy and entropy of water and dry saturated steam, for any particular pressure, are obtained from the steam tables. These values of enthalpies and entropies are plotted and then liquid line and dry saturated line is obtain.The Mollier diagram has the following lines: 1.Dryness fraction lines, 2. Constant volume lines, 3. Constant pressure lines, 4. Isothermal lines, 5. Isentropic lines, and 6. Throttling lines	2 (Diagm.) 2	4

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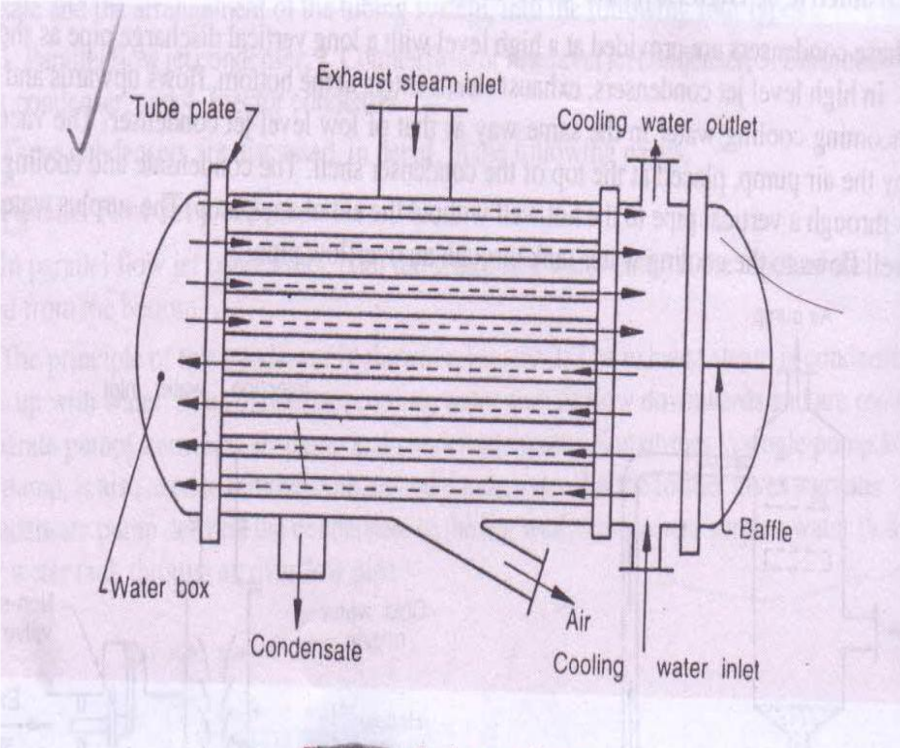
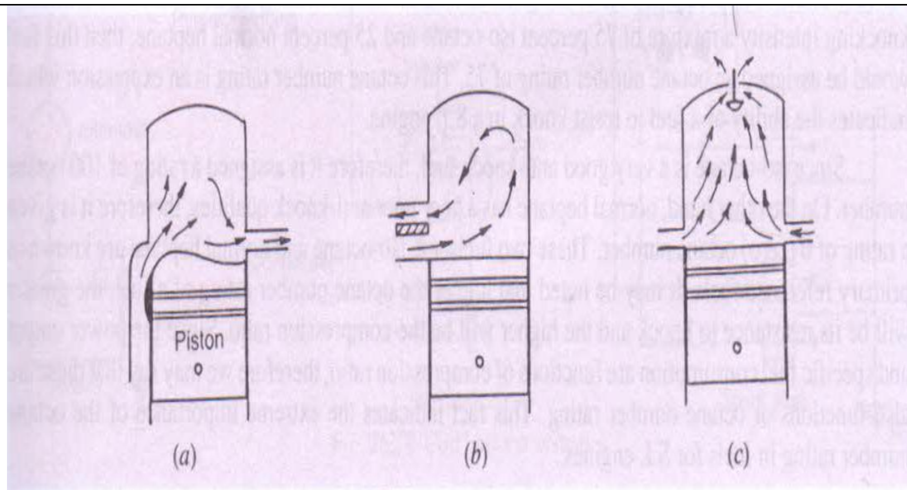
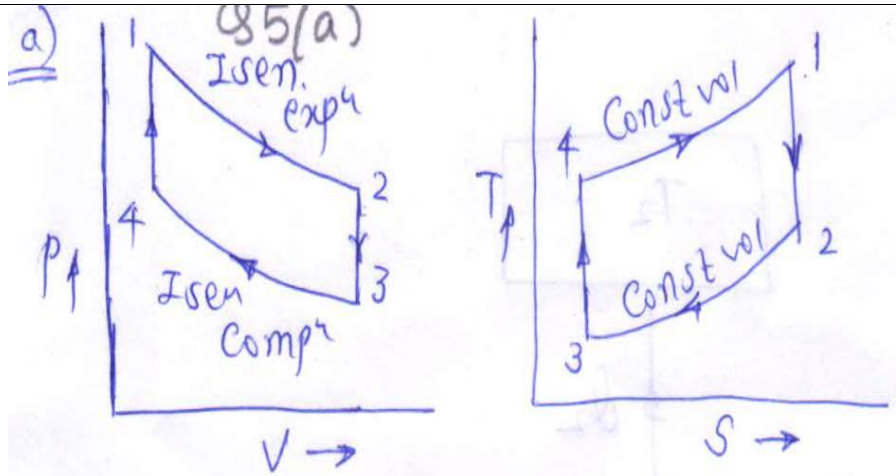
<tr><td>e</td><td>

Surface condenser.

Suface Condensers
A surface condenser has a great advantage over the jet condensers, as the condensate does not mix up with the cooling water. As a result of this, whole condensate can be reused in the boiler. This type of condenser is essential in ships which can carry only a limited quantity of fresh water for the boilers. It is also widely used in land installations, where inferior water is available or the better quality of water for feed is to be used economically.
Fig. shows a longitudinal section of a two pass surface condenser. It consists of a horizontal cast iron cylindrical vessel packed with tubes, through which the cooling water flows. The ends of the condenser are cut off by vertical perforated type plates into whic'i water tubes 'are fixed. This is done in such a manner that the leakage of water into the centre condensing space is prevented. The water tubes pass horizontally through the main condensing space for the steam. The steam enters at the top and is forced to flow downwards over the tubes due to the suction of the extraction pump at the bottom.
The cooling water flows in one direction through the lower half of the tubes and returns opposite direction through the upper half, as shown in Fig.</td><td>2 (Diagm.)

2</td><td>4</td></tr>
</table>

f	 Fig. 26.16. Types of scavenging. **Defination:-** The process of removing burnt gases, from the combustion chamber of the engine cylinder, is known as scavenging. Now we shall discuss the scavenging in four-stroke and two-stroke cycle engines **Types of Scavenging** - Though there are many types of scavenging, yet the following are important from the subject point of view: 1.Crossflow scavenging. In this method, the transfer port (or inlet port for the engine cylinder) and exhaust port are situated on the opposite sides of the engine cylinder (as is done in case of two-stroke cycle engines). The piston crown is designed into a particular shap ,so that the fresh charge moves upwards and pushes out the burnt gases in the form of cross tlow as shown in Fig. (a). 2.Backflow or loop scavenging. In this method, the inlet and outlet ports are situated on the same side of the engine cylinder. The fresh charge, while entering into the engine cylinder, forms a loop and pushes out the burnt gases as shown in Fig. (b). 3.Uniflow scavenging. In this method, the fresh charge, while entering from one side (or sometimes two sides) of the engine cylinder pushes out the gases through the exit valve situated on the top of the cylinder. In unitlow scavenging, both the fresh charge and burnt gases move in the same ard direction as shown in Fig.(c)	1 (Diagm.) 1 (Defination) 2 (Types)	4
5	**Attempt any two**		**16**

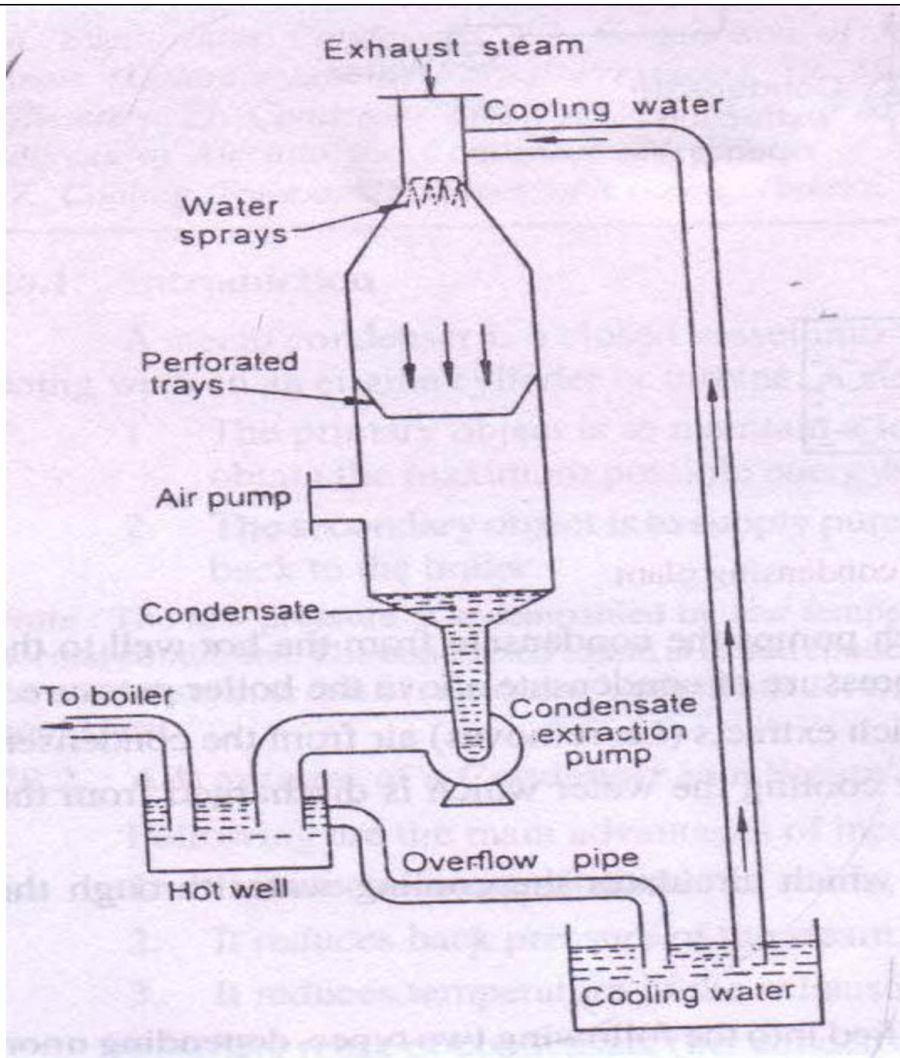
a	a) Q5(a)  **Given** $P_3 = 1$ bar $T_3 = 18°C = 291$ K $Q_{4-1} = 250$ kJ/kg Assume $C_v = 0.713$ kJ/kg K $\gamma = 1.4$		8

	1) Maximum Temp in cycle (T_1): For an isentropic compression 3-4 $\frac{T_3}{T_4} = \left(\frac{v_4}{v_3}\right)^{\gamma-1} = \left(\frac{1}{r}\right)^{\gamma-1} = \left(\frac{1}{8}\right)^{1.4-1}$ $= \frac{1}{8^{0.4}} = \frac{1}{2.29} = 0.44$ $\therefore T_4 = \frac{291}{0.44}$ $\therefore T_4 = 661.37 K$ we know that $Q_{supp} = m C_v (T_1 - T_4)$ $250 = 1 \times 0.713 (T_1 - 661.37)$ $T_1 = 1012 K$	2	
	2) Air Standard Efficiency :- $\eta = 1 - \frac{1}{r^{(\gamma-1)}} = 1 - \frac{1}{8^{(1.4-1)}}$ $\eta = 56.47\%$	2	
	3) Heat Rejected :- we know for 1-2 process $\frac{T_2}{T_1} = \left(\frac{v_1}{v_2}\right)^{\gamma-1} = \left(\frac{1}{r}\right)^{\gamma-1}$ $\therefore T_2 = T_1 \times 0.44$ $\therefore T_2 = 445.28 K$ $\therefore$ Heat Rejected $Q_{rej} = m C_v (T_2 - T_3)$ $= 1 \times 0.713 (445.28 - 291)$ $Q_{rej} = 110 kJ$	2	

	4) WID per cycle: W = Heat Supplied - Heat Rejected = 250 - 110 W = 140 KJ	2	
b i	Dalton'S Law 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	8
ii	Sources of Air into the Condenser The following are the main sources through which the air may en r into the condenser: 1.The dissolved air in the feed water enters into the boiler, whicfri rn enters into the condenser with the exhaust steam. . 2. The air leaks into the condenser, through various joints, due to high vacuum pressure in the condenser. 3. In case of jet condensers, dissolved air with the injection water enters into the condenser	4	

c	Given $p = 6\ bar$ $t_w = 25^\circ C$ $x = 0.9$ $t_{sup} = 250^\circ C$ $C_p = 2.3\ kJ/kgK$ Steam table → pressure of 6 bar, $h_f = 670.4\ kJ/kg$, $h_{fg} = 2085\ kJ/kg$ & $t = 158$ 1) When the steam is wet total heat of 1kg of wet steam $h = h_f + x h_{fg} = 670.4 + 0.9 \times 2085 = 2546.9$ Since the water is at temp. of $25^\circ C$ heat already in water $= 4.2 \times 25 = 105\ kJ$ heat actually required $= 2546.9 - 105 = 2441.9\ kJ$ 2) When steam is dry saturated total heat of 1kg of dry saturated steam $h_g = h_f + h_{fg} = 670.4 + 2085 = 2755.4\ kJ$ heat actually required $= 2755.4 - 105 = 2650.4\ kJ$ 3) When the steam is super heated total heat of 1kg of super heated steam $h_{sup} = h_g + C_p(t_{sup} - t)$ $= 2755.4 + 2.3(250 - 158.8)$ $= 2965.16\ kJ$ heat actually required $= 2965.16 - 105$ $= 2860.16\ kJ$	2 2 4	8

6	**Attempt any four**		**16**
a	**Thermodynamic Equilibrium** A system is said to be in thermodynamic equilibrium, if it satisfies the following three requirerenents of equilibrium. l . Mechanical equilibrium. A system is said to be in mechanical equilibrium, when there is no unbalanced forces acting on any part of the system or the system as a whole. 2. Thermal equilibrium. A system is said to be in thermal equilibrium, when there is no temperature difference between the parts of the system or between the system and the surroundings. 3. Chemical equilibrium. A system is said to be in chemical equilibrium, when there is no chemical reaction within the system and also there is no movement of any chemical constituent fromone part of the system to the other.	4	4
b i	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 =mg/mf Where mg = Mass of actual dry steam, mf = Mass of water in suspension, and m = Mass of wet steam = mg + mf	2	4
ii	Latent heat of vaporisation. It is the amount of heat absorbed to evaporate 1 kg of waterat its boiling point or saturation temperature without change of temperature. It is denoted by hfg and its value depends upon the pressure. The heat of vaporisation of water or latent heat of steam is 2257 kJ/kg at atmospheric pressure.	2	

c	 [redacted]. Parallel flow jet condenser.	2 (Diagm.)	4
	Parallel Flow Jet Condensers In parallel flow jet condensers. both the steam and water enter at the top. and the rnixture is removed from the bottom. The principle of this condenser is shown in Fig. The exhaust steam is condensed when it mixes up with water. The condensate. cooling water and air flow downwards and are removed by two separate pumps known as air pump and condensate pump. Sometimes. a single pump known wet air pump. is also used to remove both air and condensate. But the former gives a greater vacuum.The condensate pump delivers the condensate to the hot well. from where surplus water flows to the cooling water tank through an overflow pipe.	2	
d	To improve the properties by addition of chemical of compound called additives The main additives as following: 1) Detergents- dispersant:	4	4

	These additives improve the detergent action of the lubricating oil by keeping the deposit in suspension form ads this additives are oil soluble. E.g.Metalics salts or organic acids 2) Pour point depressors: Lubricant contain paraffin compound and form wax precipitates as they cooled .Wax reduce fluidity of oil temperature pour depressants are add to lower the pour points of lubrication oil. e.g. polymerized phenols , Easter ,alkylated naphthalene oil 3) Anti-foam agent: This assistive prevent the formation of foam by reducing surface tension, which allow air bubble to separate from oil more rapidly. e.g. Silicon polymers 4) Rust inhibitors: These prevent rusting of ferrous engine parts during storage and from acidic moisture accumulation during cold engine operation e.g. Metal sulphates, fatty acid and amines.		
e	I According to type of Contact 1.Direct type of contact heat exchanger 2.Indirect type of contact heat exchanger II.According to flow of coolant 1.Parellel flow heat exchanger 2.Counter flow heat exchanger III According to construction 1.Shell and tube heat exchanger 2.Double pipe heat exchanger 3.Plate type heat exchanger 4.Plate and shell type heat exchanger. IV. According to nature 1.Natural type of heat exchanger 2.Forced type of heat exchanger. Materials for heat exchangers:	2 2 (any 4)	4
f	**Kelvin - Planck Statement**. According to Kelvin-Planck 'It is impossible to construct an engine working on a cyclic process, whose sOle2rposeis to convert heat energy from a single thermal reservoir into an equivalent amount of work. **Clausius Statement**. According to Clausius statement "It is impossible jor a self actingmachine. working In a cycLic process, to transfer neat jrom a body at a lower temperature to a body at a higher temperature without the aid of an external agency.	2 2	4