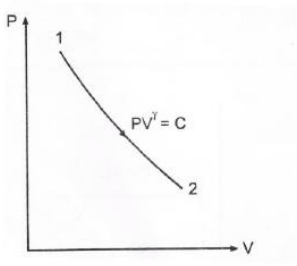
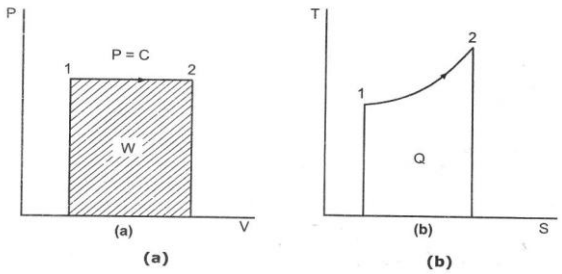
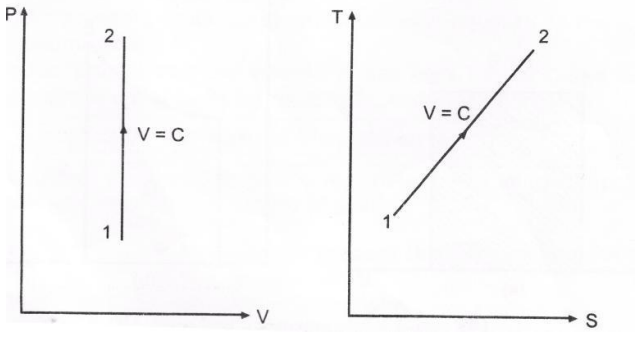
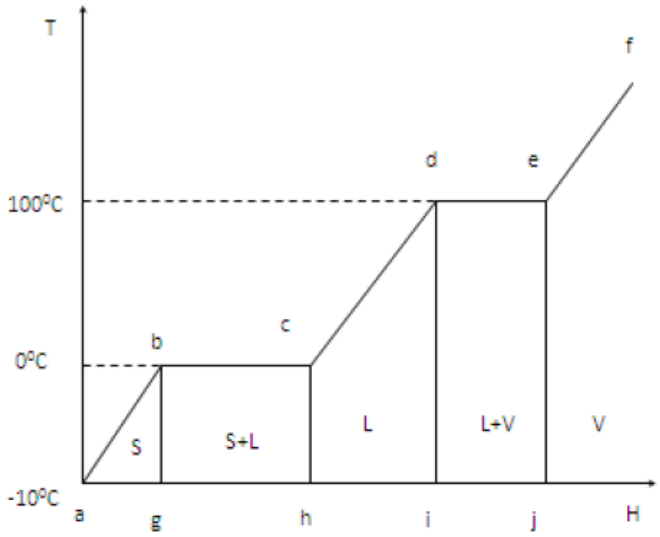
Important Instructions to examiners:

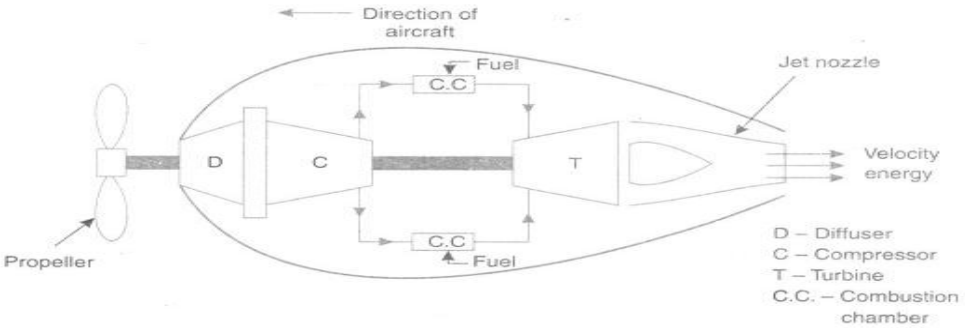
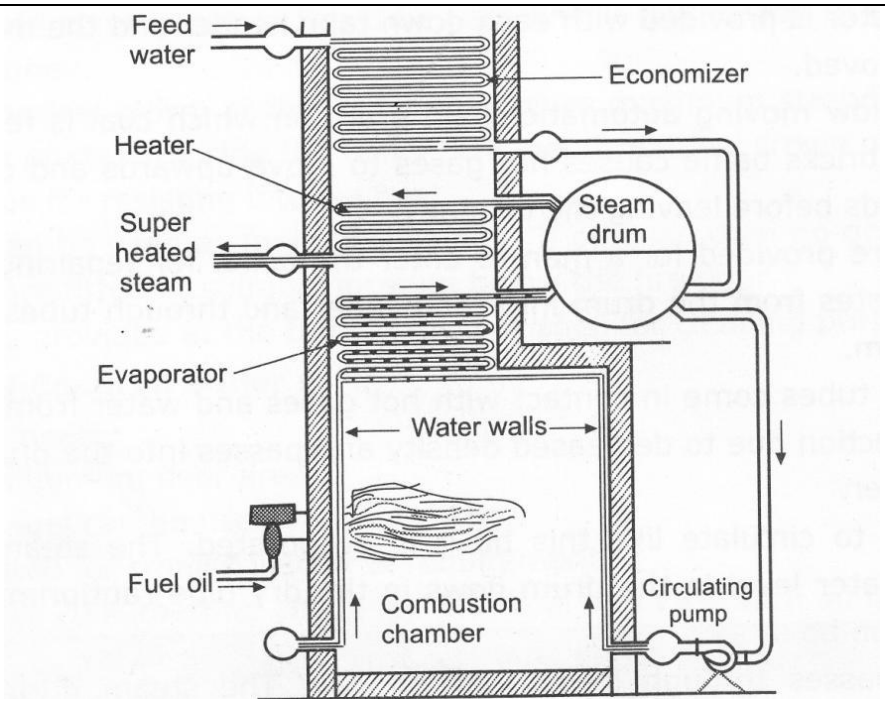
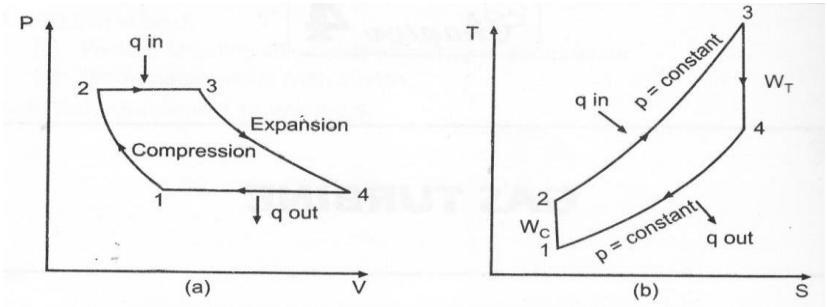
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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.	Sub Q. No.	Answer	Marking Scheme
1	**a)**	**Attempt any six of the following**	**12**
1a)	**i)**	**What is isentropic process? Plot it on P-V diagram.**	2
	Answer:	Isentropic Process: The reversible adiabatic or frictionless adiabatic process is known as Isentropic Process. It is a constant entropy process.  P-V Diagram Isentropic process	1 1
1a)	**ii)**	**State why multistaging is necessary in air-compressor**	
	Answer:	**Necessity of multistaging with intercooling in air compression:** The large pressure ratio gives rise in high compression ratio and high discharged temperature which produce adverse effect on the efficiency and performance of the system. In such application efficiency decreases and works done and power increases. So to get better performance and saving in work and power multistaging with intercooling is necessary.	2

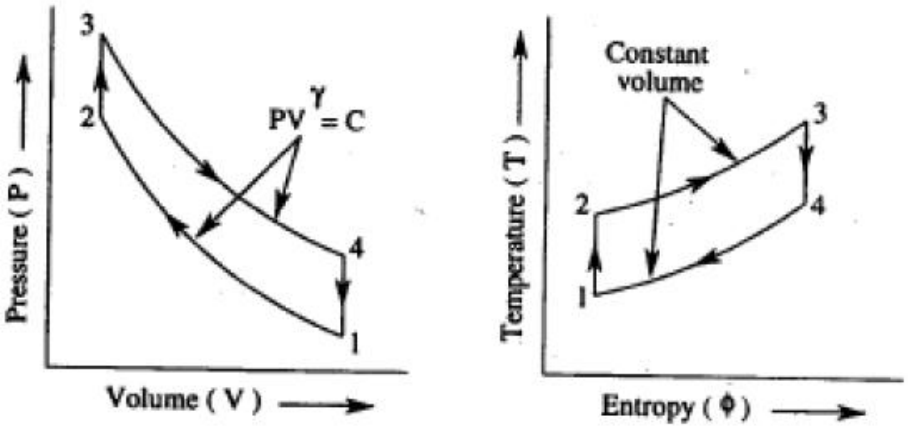
1a)	**iii)**	**List out merits of liquid fuels over gaseous fuels.**	
	Answer:	i) Comparatively Less space required to storage. ii) Comparatively Less chance of explosion. iii) There is no loss of heat during storage. iv) Comparatively less inflammable. v) Comparatively easy to handle. vi) Comparatively low cost.	**For any four ½ mark each**
1a)	**iv)**	**Define Piston Displacement related to air compressor.**	
	Answer:	**Piston Displacement:** It is the volume swept through by the piston in cubic meter per minute for single acting compressor. For double acting compressor it is the volume swept through by both the sides of piston.	**2**
1a	**v)**	**Define Wet steam and Superheated steam.**	
	Answer:	**1. Wet steam-** When steam contains some water particles in suspended form, is known as wet steam. The suspended water particles are known as moisture . **2. Superheated steam:** If dry saturated steam is heated beyond its saturation temperature, its temperature will increase and this steam is called as superheated steam. Superheated steam have no moisture content.	**1** **1**
1a)	**vi)**	**List out Applications of gas turbine.**	
	Answer:	**Applications of gas turbine:** *(Any four)* 1. Supercharging of I.C. engine 2. For locomotive Propulsion 3. Ship Propulsion 4. Industrial application 5. Air craft engine 6. Electric power generation 7. Turbo-jet engine 8. Turbo-prop engine 9. Ram-jet engine 10. Pulse-jet engine	**For any four ½ mark each**
1a	**vii)**	**State disadvantages of conventional energy sources**	
	Answer:	**disadvantages of conventional energy sources** 1. Once a conventional energy source is used up it cannot be replaced again. 2. conventional energy source are highly polluting sources and increase the greenhouse gasses. 3. The conventional energy source are responsible for all kinds of non-biodegradable material accumulation. 4. The exposure to conventional energy sources has increased the level of pollution. 5. The rise in temperature due to greenhouse gas accumulation.	**1 Mark each For any two points**

1a)	**viii)**	**What is Calorific value" of fuel? Define High Calorific value.**	**2**
	Answer:	**"Calorific value" of fuel:** It is defined as the amount of heat liberated during complete combustion of 1 kg of fuel. It is expressed in terms of KJ/kg. **H.C.V. of Fuel:** Higher calorific value of fuel is defined as amount of heat energy obtain by the complete combustion of 1kg of fuel, when the products of its combustion are cooled down to the temperature of supplied air.	**1 Mark** **1Mark**
1	**b**	**Attempt any two of the following**	**8**
1b)	**i)**	**Represent isobaric and isochoric process on P-v and T-S diagram**	**4**
		1) Isobaric Process  P-V Diagram T-S Diagram **2) Isochoric Process:**  P-V Diagram T-S Diagram	**2** **2**
1b)	**ii)**	**Describe the different phases of formation of steam.**	**4**
	Answer:	**(*Note: Description:2 marks and Diagram:2 marks.)*** **Different phases of Formation of steam-** Consider formation of steam from ice at -10^0 C **i) Solid phase-** When the heat is added in ice which is at -10^0 C, the temperature of ice increases to 0^0 C as shown in figure by process a-b.in this stage solid phase exists.	**2**

		ii) Solid+ Liquid phase- The point b is called is saturation point when heat is further added this heat cannot increase the temperature but ice is converted into water that means phase transformation takes place, thus in-between region b-c, solid and liquid phase exists. **iii) Liquid phase**- From point c-further heat is added up to 1000 C, in this region no phase change takes place, there is only liquid phase present. **iv) Liquid+ Vapour phase**- Point d is saturation point; further addition of heat will not increase the temperature but liquid phase change into vapors phase. In this region only liquid and vapour is present. **v) Vapour phase**- Point e is called as saturation point, further adding heat increase the temperature of steam which is called as superheating and in this region only vapour is present.  Fig. Formation of steam	**2**
1b	**iii**	**Explain working of turbo-prop engine**	**4**
		Answer: Turboprop engine: (*Note: Working: 2 marks and Diagram: 2 marks.)* **Working:** Figure shows a turboprop system employed in aircrafts. Here the expansion of gases takes place partly in turbine 80% and partly 20% in the nozzle. The power developed by the turbine is consumed in running the compressor and the propeller. The propeller and jet produced by the nozzle give forward motion to the aircraft. The turboprop entails the advantages of turbojet (i.e. low specific weight and simplicity in design) and propeller (i.e. high power for takeoff and high propulsion efficiency at speeds below 600km/h). The overall efficiency of the turbo prop is improved by providing the diffuser before the compressor as shown. The pressure rise takes place in the diffuser. This pressure rise take due to conversion of kinetic energy of the incoming air (equal to aircraft velocity) into pressure energy by diffuser. This type of compression is known as "ram effect".	**2**

		 Fig : Turbo Prop Engine	2
2		**Attempt any four of the following**	**4*4=16**
2	a	**Draw a neat and labelled sketch of La-mont Boiler.**	**4**
		 **Fig : La Mont Boiler**	**4**
2	B	**Draw P-V and T-S diagram of Brayton Cycle and mention each process in it.**	**4**
		Brayton cycle  **P-V diagram** **T-S diagram**	**2**

		Processes in Brayton Cycle: 1. Process 1-2: Reversible Adiabatic Compression process 2. Process 2-3: Heat addition at constant Pressure 3. Process 3-4: Reversible Adiabatic Expansion process 4. Process 4-1: Heat rejection at constant Pressure	**2**
2	**c**	**Define the following** **i) Dryness fraction ii) Degree of superheat** **iii) Sensible heat iv) Latent Heat**	**4**
	Answer:	**i) Dryness Fraction:** It is defined as a fraction of steam that is in vapour form in liquid vapour is called dryness fraction. $$x = \frac{Mv}{Mv + ML}$$ Where x – Dryness fraction Mv – mass of vapour (dry steam) contain in steam ML = mass of water in suspension in steam Dryness fraction is ratio of the mass of actual dry steam to the mass of wet steam. **ii) Degree of Superheat:** It is difference between the temperature of Superheated vapour and the saturation temperature correspondingly to given pressure is said to be Degree of Superheat. **iii) Sensible heat**: It is defined as the quantity of heat which can be sensed by the thermometer. OR The amount of heat added up to saturation temperature is called sensible heat. **iv) Latent heat**: It is defined as the quantity of heat required for phase change of working substance at saturation temperature. OR The amount of heat added at saturation temperature is called latent heat.	**1** **1** **1** **1**
2	**d**	**Calculate the enthalpy of 1 kg of steam at a pressure of 8 bar and dryness fraction of 0.8. How much heat would be required to raise 2 kg of this steam from water at 20°C? Assume P=8bar, hf= 720.9 kJ/kg, h_{fg}= 2046.5 kJ/kg**	**4**
	Answer:	**Given** :- 1) For 1 Kg of steam m=1Kg x=0.8 h_f=720.9 kJ/kg h_{fg}= 2046.5 kJ/kg **$h = m(h_f + x h_{fg})$** **h**=1[720.9 + (0.8 X 2046.5)] **Enthalpy** **h= 2358.1 KJ**	**1** **1**

		2) Heat required for 2Kg of steam from 20^0C of water m= 2Kg C_p=4.2 KJ/KgK This value is of enthalpy at 0^0C. For 20^0C heat in the water= specific heat of water X Rise in temperature = 4.2 X 20 = 84 KJ **Heat required per Kg of steam= 2358.1 – 84 = 2274.1 KJ** And **Heat required of 2 Kg of steam= 2 X 2274.1 = 4548.2KJ**	**1** **1**
2	**e**	**Explain different modes of heat transfer**	**4**
	Answer :	**1) Conduction-** It is the mode of heat transfer from one part of substance to another part of same substance or one substance to another without displacement of molecules or due to the vibrations of molecules. **Example-**Heat transfer in metal rod. **2) Convection:** It is the mode of heat transfer from one part of substance to another part of same substance or one substance to another with displacement of molecules or due to the fluid flowing. **Example:** Heat flow from boiler shell to water. **3) Radiation:** It is the transfer of heat through space or matter. For Radiation there is no need of medium as like convection and conduction. It passes through vacuum in the form of electromagnetic waves. **Example:** The energy from sun to the earth surface.	**4**
2	**f**	**Represent Otto cycle and Diesel Cycle on P-V and T-s Diagram and Write equation for Air Standard Efficiency of Otto cycle.**	**4**
		1. Otto cycle  	**1 ½ Mark**

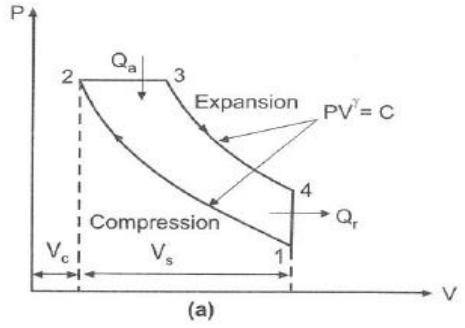
Air standard efficiency of Otto Cycle:-

$$\eta = 1 - \frac{1}{r^{\gamma-1}}$$

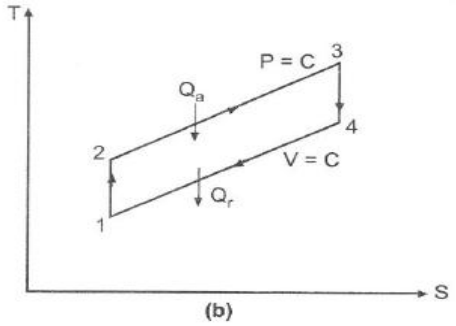
1 Mark

Where, r = compression ratio

2. Diesel Cycle



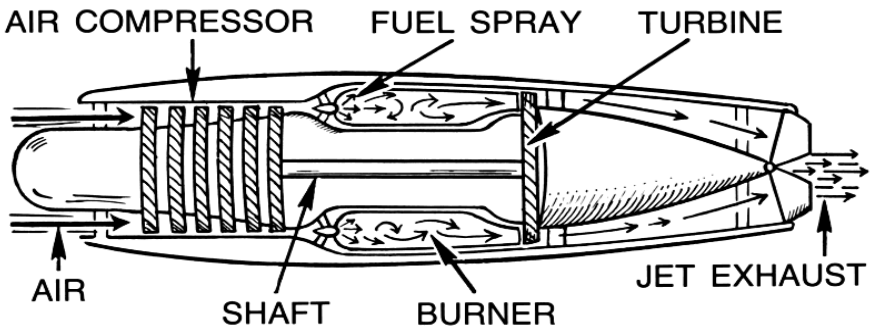
P - V diagram



T-S diagram

1 ½ Mark

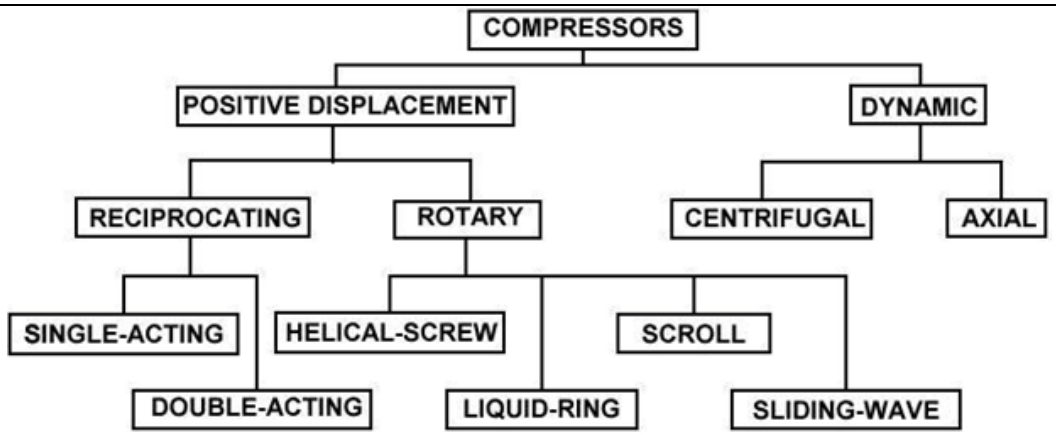
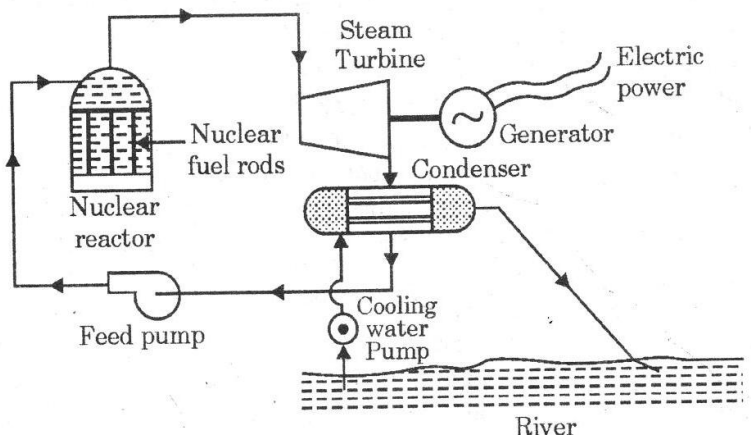
3		**Attempt any FOUR of the Following**	**16**
3	**a)**	**Explain construction and working of turbojet Engine.**	**4**
	Answer:	**Turbo-jet Engine**	

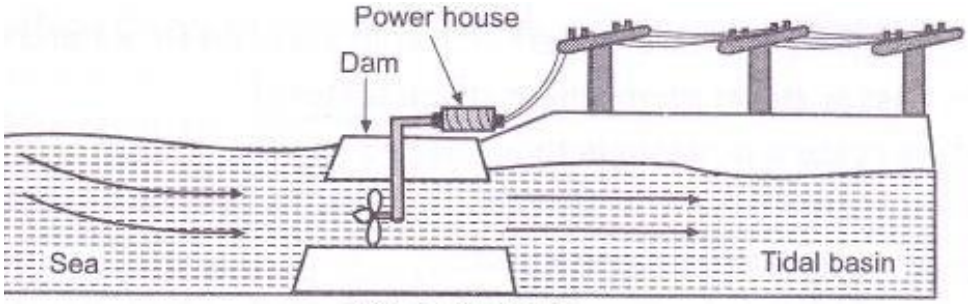
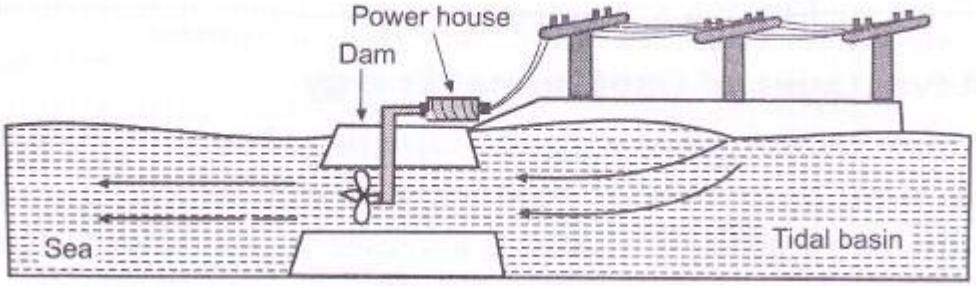


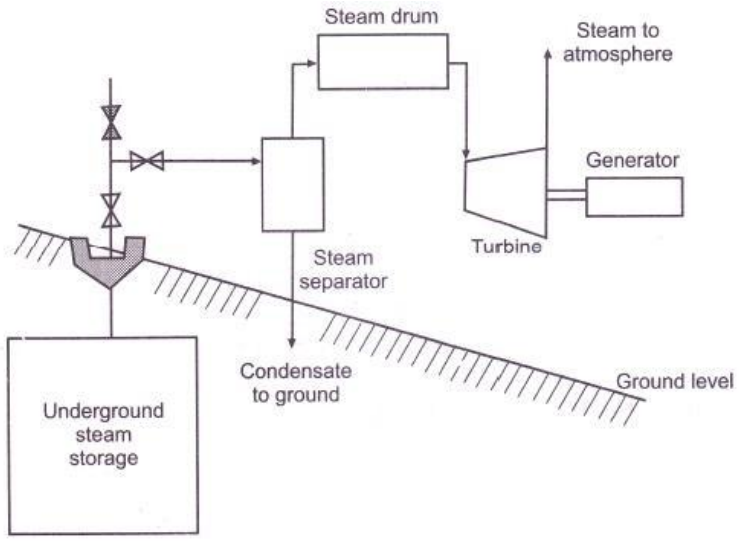
02

Turbo-jet engine consists of diffuser, compressor, combustion chamber turbine and nozzle. At entrance air diffuser causes rise in pressure in entering air by slowing it down. A rotary compressor, which raises the pressure of air further to required value and delivers to the combustion chamber. The compressor is axial or radial type driven by turbine. In the combustion chamber, fuel is sprayed, as result of this combustion takes place at constant pressure and the temperature of air is raised.

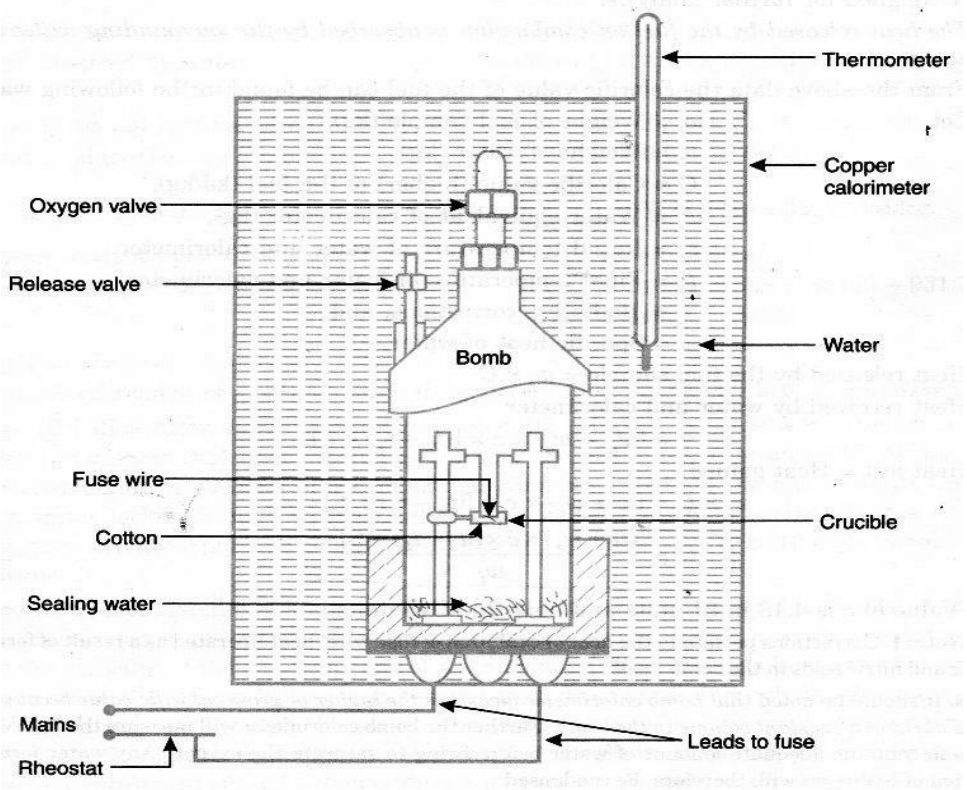
02

		Then this product of combustion passes into the gas turbine gets expanded and provides necessary power to drive the compressor. The discharge nozzle in which expansion of gases is completed and thrust of propulsion is produced. The velocity in the nozzle is grater then flight velocity.	
3	**b)**	**State Classification of air Compressor.**	**4**
	Answer:		**04**
3	**c)**	**Explain working of Nuclear Power Plant with simple diagram.**	**4**
	Answer:	Nuclear Power Plant:  The basic components of Nuclear Power Plant are shown in the above fig. Steam is generated in the nuclear reactor of Nuclear Power Plant by using heat generated by nuclear reaction. The steam generated is passed through steam turbine where part of its thermal energy is converted into mechanical energy which is further used for generating electric power. The steam coming out of steam turbine is condensed in condenser and condensate is supplied back to the nuclear reactor with the help of feed pump and cycle is repeated.	**02** **02**

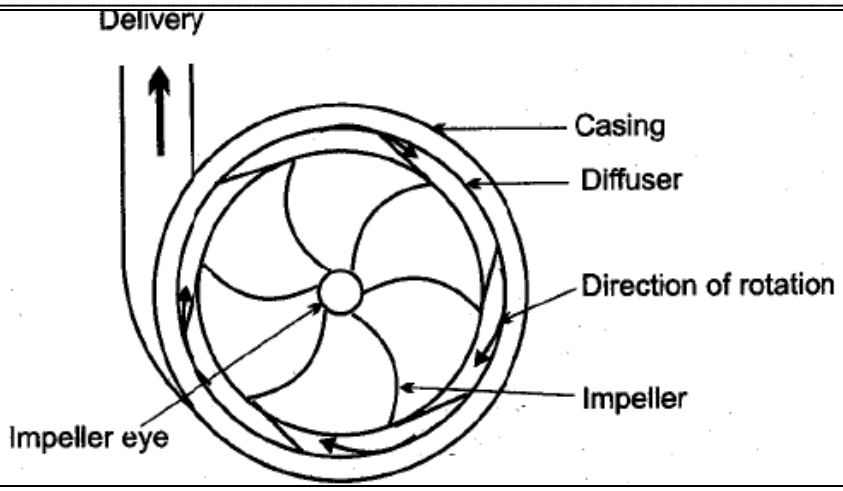
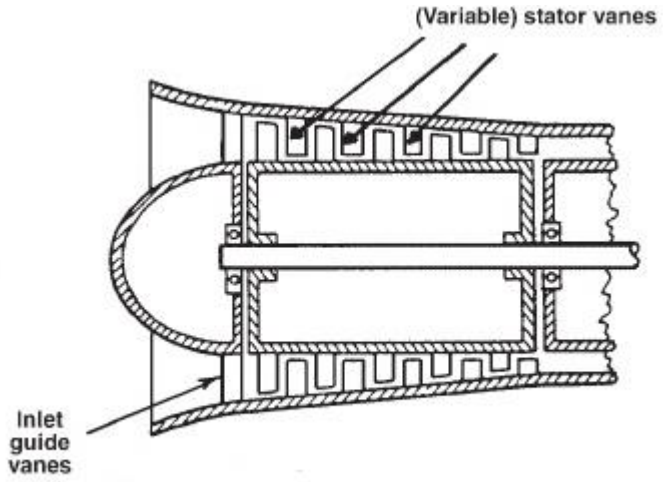
3	d)	**Explain the working of Tidal power plant with a neat sketch.**	4
	Answer:	Working of Tidal power plant: During high tide the water flow from sea into the tidal basin through water turbine as the level of water in sea is more than tidal basin. This operates the turbine and generator and power is produced. Potential energy of sea water converted into mechanical energy by turbine and it converts into electrical by generators. During low tide water flow from tidal basin into sea as water level in the sea is lower than basin level in both cases generation of power is same. Only difference in that rotation of turbine blade is opposite.  Tide comming in  Tide going out	02 02
3	e)	**Explain ultimate analysis and proximate analysis of coal.**	4
	Answer:	**Ultimate Analysis:** Ultimate analysis is complete breakdown of coal into chemical constituents. This analysis is important for large scale trials. It serves the basis for calculation of the amount of air required for complete combustion of 1kg of fuel. It gives percentage content on mass basis of carbon, hydrogen, oxygen, Sulphur and ash. We are able to calculate the Calorific value of coal. **Proximate Analysis:** Proximate analysis is complete breakdown of coal into physical constituents without knowledge of analytical chemistry. This analysis made by means of a chemical balance &temperature control Furnace. The component in the analysis is fixed carbon volatile matter, moisture& ash. This is used to calculate the heating value of coal.	02 02

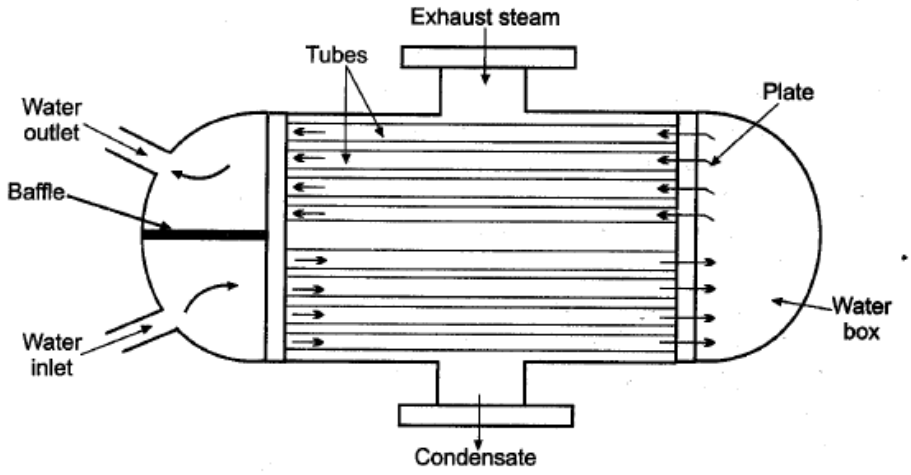
3	**f)**	**A coal has the following composition by mass: C= 85%, H2= 4%, S= 1% O2 =2%, N2 =1%, and remaining is Ash. Find HCV and LCV of fuel.**	**4**
		Given Data: Carbon C = 85% = 0.85 Hydrogen = H2 = 4% = 0.04 Oxygen = O2 = 2% = 0.02 Nitrogen = N = 1% = 0.01 Sulphur = S =1% = 0.01 Ash = 7% = 0.07 Dulong's formula: **H.C.V. of coal =** 33800 C + 144500 (H_2 - O_2/8) + 9300 S KJ / Kg =33800 x 0.85 + 144500 (0.04 - 0.02/8) + 9300 x 0.01 = 34241.75 KJ / Kg **L.C.V. of coal =** H.C.V.- 9H_2 x 2442 KJ / Kg = 34241.75 – (9 x 0.04) x 2442 = 33362.63 KJ / Kg	**02** **02**
04		**Attempt any TWO of the Following**	**16**
4	**a)**	**Attempt the following**	**8**
4a)	**i)**	**Explain working of Geothermal Power plant with the help of neat sketch.**	**4**
	Answer:	**i) Working of geothermal power plant**  Figure shows geothermal power plant which consists of the following main components: Underground steam storage, steam separator, steam separator, turbine and Generator. Steam is present in the earth crust at 10 km depth is about 2000 C. It is stored in the underground steam storage tank. This steam is taken out through pipe and valve and passed through steam separator. In steam separator moisture content in the steam is taken out and dry steam is allowed to pass in steam	**02** **02**

		drum where steam is stored. The moisture content in steam is then injected into the ground. As per requirement steam is passed over the turbine and kinetic energy of steam is converted into mechanical work. Turbine is connected to the generator by shaft which generates power. Mechanical energy of shaft is converted in to electrical energy by generator.	
4a)	**ii)**	**Explain construction and working of Bomb calorimeter.**	**4**
	Answer:	**Construction :** The calorimeter is made of austenitic steel which provides considerable resistant to corrosion and enables it to withstand high pressure. In the calorimeter use of a strong cylindrical bomb in which combustion occurs. The bomb has two values at the top. One supplies oxygen to the bomb and other releases the exhaust gases. A crucible in which a weighed quantity of fuel sample is burnt is arranged between the two electrodes as shown in fig. The calorimeter is fitted with water jacket which surrounds the bomb To reduce the losses due to radiation calorimeter is further provided with a jacket of water and air. A stirrer for keeping the temperature of water uniform and a thermometer the temperature up to accuracy of 0.0010 C is fitted through the lid of the calorimeter. **Working :** The calorimeter is made of austenitic steel which provides considerable resistant to corrosion and enables it to withstand high pressure. In the calorimeter use of a strong cylindrical bomb in which combustion occurs. The bomb has two values at the top. One supplies oxygen to the bomb and other releases the exhaust gases. A crucible in which a weighed quantity of fuel sample is burnt is arranged between the two electrodes as shown in fig. The calorimeter is fitted with water jacket which surrounds the bomb To reduce the losses due to radiation calorimeter is further provided with a jacket of water and air. A stirrer for keeping the temperature of water uniform and a thermometer the temperature up to accuracy of 0.0010 C is fitted through the lid of the calorimeter. The heat released by the fuel on combustion is absorbed by the surrounding water and the calorimeter. From the above data the calorific value of the fuel can be found.	**1** **1**

			02
4	b)	**Derive relation between P, V and T during adiabatic process.**	8
	Answer:	Pressure (P) , Volume (V) & Temperature (T) relation for adiabatic process: For adiabatic Process, $PV^{\gamma} = C$ $P_1 v_1^{\gamma} = P_2 v_2^{\gamma}$ $\frac{P_2}{P_1} = (\frac{V_1}{V_2})^{\gamma}$ ..... (1) From general gas equation $\frac{PV}{T} = C$ $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$	02

		$\frac{T_2}{T_1} = \frac{P_2V_2}{P_1V_1}$ .....(2) From (1) $\frac{V_2}{V_1} = (\frac{P_1}{P_2})^{1/\gamma}$ ..... (3) Put equation (3) into equation (2) $\frac{T_2}{T_1} = \frac{P_2}{P_1}(\frac{P_1}{P_2})^{1/\gamma}$ $\frac{T_2}{T_1} = (\frac{P_2}{P_1})^{\frac{\gamma-1}{\gamma}}$ $\frac{P_2}{P_1} = (\frac{T_2}{T_1})^{\frac{\gamma}{\gamma-1}}$ .....(4) From equation (1) & (4) $\frac{P_2}{P_1} = (\frac{V_1}{V_2})^{\gamma} = (\frac{T_2}{T_1})^{\frac{\gamma}{\gamma-1}}$ $\frac{P_2}{P_1} = (\frac{V_1}{V_2})^{\gamma} = (\frac{T_2}{T_1})^{\frac{\gamma}{\gamma-1}}$	02 02 02
4	**C)**	**Explain the construction and working of:**	**8**
4c)	**i)**	**Centrifugal compressor.**	**4**
	Answer:	**Centrifugal compressor:** Fig. shows centrifugal compressor, it is simple in construction. It consists of rotor (i.e. impeller), impeller eye and diffuser. In impeller number of curved vanes is fitted symmetrically. Impeller rotates in an air tight volute casing. The casing is designed that the kinetic energy of the air is converted into pressure energy before it leaves the casing. Mechanical energy is provided to impeller by some external means. As impeller rotates it sucks air from impeller eye, increases its pressure due to centrifugal force and forces the air to flow over diffuser. The pressure of air further increases during its flow over diffuser. Finally, the air at high pressure is delivering to receiver. The air enters in the impeller radially and leaves vanes axially.	2

			2
4c)	ii)	**Axial flow Compressor:-**	4
		Axial flow compressor: The basic components of an axial flow compressor are a rotor and stator, the former carrying the moving blades and the latter the stationary rows of blades. The stationary blades convert the kinetic energy of the fluid into pressure energy, and also redirect the flow into an angle suitable for entry to the next row of moving blades. Each stage will consist of one rotor row followed by a stator row, but it is usual to provide a row of so called inlet guide vanes. This is an additional stator row upstream of the first stage in the compressor and serves to direct the axially approaching flow correctly into the first row of rotating blades. For a compressor, a row of rotor blades followed by a row of stator blades is called a stage. In an axial compressor, the flow rate tends to be high and pressure rise per stage is low. It also maintains fairly high efficiency. 	2 2

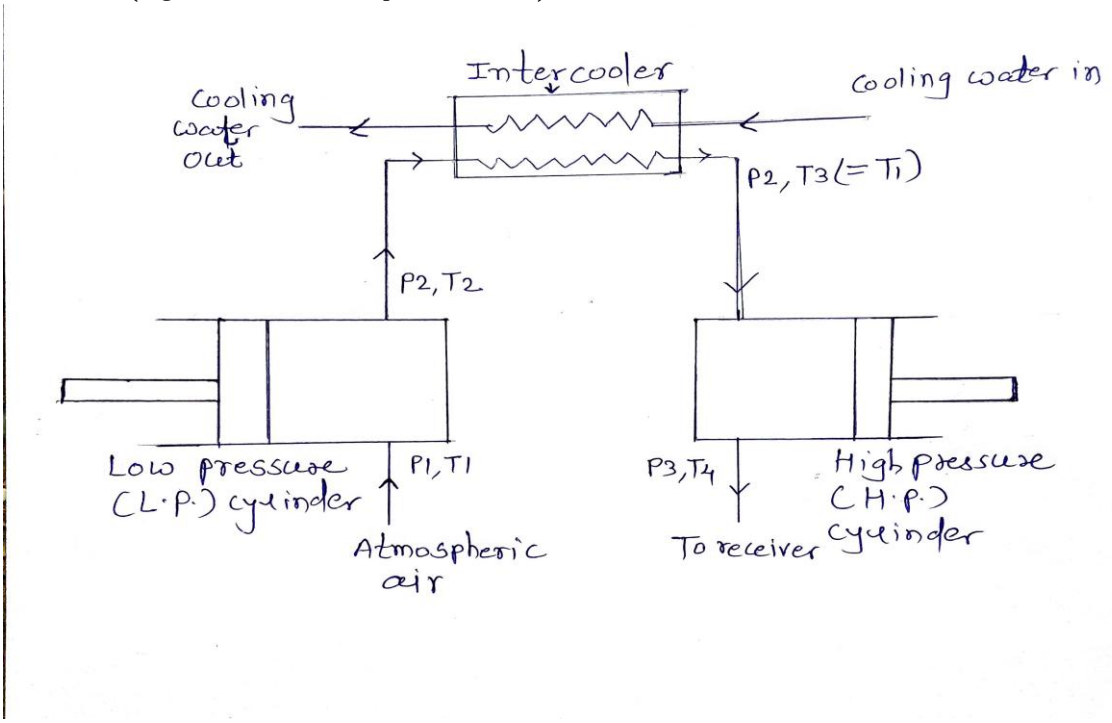
5		**Attempt any TWO of the following**	**16**
5	**a)**	**Attempt the following:**	**08**
5a)	**(i)**	**Write the construction and working of two pass down flow surface condenser.**	**04**
		: Two pass down flow surface condenser: (Figure:2 marks, Construction:1Mark,Working:1mark)  **Figure. Two pass down flow surface condenser** **Construction:** It consists of horizontal cast iron cylindrical vessel pack with tubes, through which the cooling water flows. The ends of the condenser are cut off by vertical perforated type plates into which water tubes are fixed. This is done in such a manner that the leakage of water in to the center condensing space is prevented. **Working:** The water tubes pass horizontally through the main condensing space for the steam. The steam enters at the top & 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 lower half of the tubes & return in opposite direction through the upper half as shown in figure. The condensate does not mix with cooling water which is used for cooling steam & convert into water; therefore whole condensate can be the reused in the boiler. It is used to increase the turbine output by maintaining backpressure on exhaust side of steam engine or turbine & the secondary function of condenser is to supply pure and hot feed water to boiler.	**2 Marks** **1** **1**
5a)	**(ii)**	**Explain function and location of condenser in steam power plant.**	**04**
		(Function: 3 marks, Location: 1 mark) **Function:** **1.** It is a device which condenses steam by heat release from steam with help of water. **2.** It maintains very low back pressure thus more work can be obtained.	**03**

		3. Temperature of condensate is more than of feed water so amount of heat supplied per kg of steam is reduced. **Location**: It locates in between Turbine and Feed pump	**01**
5	**b)**	**Differentiate between reciprocating and rotary air compressor.**	**08**
	Answer :	**Difference between reciprocating and rotary air compressor (any 8 points)**	**1 mark for each point (Any 8 Points)**

Sr. No.	Reciprocating air compressor	Rotary air compressor
1	It is having to and fro motion.	It is having rotary motion
2	Air supply is intermittent.	Air supply is continuous.
3	Lubrication system is complicated.	Lubrication system is simple.
4	Maximum delivery pressure is upto 1000 bar.	Maximum delivery pressure is upto 10
5	Maximum free discharge is about 300 m^3/min.	Maximum free discharge is about 3000 m^3/min
6	Speed is lesser	Speed is higher
7	Balancing is major problem	No balancing problem
8	Frictional losses are more	Frictional losses are less
9	Size of compressor is large for the given discharge	Size of compressor is small for the give discharge
10	It is suitable for low discharge and high pressure	It is suitable for high discharge and low pressure
11	Application- Auto workshop, service stations, air brake system etc.	Application- Torbocharger, supercharg Blower, Hair Drier etc.

5	**c)**	**During a boiler trial coal analysis on mass basis was reported as C=62.4%, H_2=4.2%, O_2=4.5% Moisture=15% and ash=13.9%. Calculate minimum air required to burn 1 kg of coal. Also calculate Higher and lower calorific value.**	**08**
		Given- C=62.4%=0.624 Kg H_2=4.2%=0.042 Kg O_2=4.5%=0.045 Kg Moisture=15%=0.15 Kg Ash=13.9%=0.139 Kg Minimum air required to burn 1 kg of coal $= \frac{100}{23}\left[\left(\frac{8}{3}C + 8H_2 + S\right) - O_2\right]$ kg $= \frac{100}{23}\left[\left(\frac{8}{3} \times 0.624 + 8 \text{ X } 0.042\right) - 0.045\right]$ $=$ 8.67 Kg	**3**

		H.C.V. of coal = 33800 C + 144500 (H_2 - O_2 /8) + 9300 S KJ / Kg = 33800x0.624+144500 (0.042 -0.045/8) = 26348.11 KJ / Kg **L.C.V. of coal** = H.C.V.- 9H_2 x 2442 KJ / Kg = 26348.11 - 9X 0.042X 2442 = 25425.034 KJ / Kg	**3** **2**
6		**Attempt any FOUR of the following**	**16**
6	**a)**	**What are applications of heat transfer in automobile?**	**4**
		Answer: Applications (any four) i)Radiator ii)Engine with components as cylinder liner, piston and piston rings, cylinder heads, exhaust valves etc. iv)Lamps v)Cooling circuits vi)Exhaust system vii)Lubricating system	**1 Mark each any four**
6	**b)**	**Explain the sources of air leakages in condenser.**	**4**
		Answer: Sources of air leakage in condenser 1.Air leak through joints and packing. Air leaks into condenser as pressure inside falls below atmospheric pressure. 2. Air also comes in condenser with the steam. The feed water supplied to the boiler contains certain amount of air dissolved in it. The dissolved air gets liberated when steam is formed and is carried with the steam into the condenser. 3. In jet condensers dissolved air in the cooling water enters the condenser. The dissolved air gets separated at low pressure in the condenser 4.Air leaks if any bypass seal is broken.	**1 Mark each any four**

6	c)	**State need of inter cooling in air compressor with suitable sketch.**	4
		Answer: (Figure:2 marks, Description: 2 marks)  **Need of intercooler-**In two stage air compressor air is compressed in first cylinder and the temperature of air is increased. If this high temperature air is not passed through intercooler and sent directly to second stage then because of high temperature volume of air increases so amount of air taken inside decreases and pressure is also automatically decreased and volumetric efficiency is also decreases. To avoid this intercooling is necessary.	**Figure: 2 marks,** **Description: 2 marks**
6	d)	**Compare closed cycle gas turbine and open cycle gas turbine.**	4
		Difference between closed cycle gas turbine and open cycle gas turbine (any 4 points)	**1 Mark each any four points**

Sr. No.	closed cycle gas turbine	open cycle gas turbine
1	Any type of working fluid with better thermodynamic properties can be used.	Only air can be used as a working fluid.
2	Maintenance cost is high.	Maintenance cost is low.
3	Working fluid circulated continuously.	Working fluid replaced continuously.
4	Mass of installation per KW is more.	Mass of installation per KW is less.
5	It avoids erosion of turbine blade due to contaminated gases.	The turbine blades wear away earlier as it gets contaminated with air.

		6	The exhaust gas from the turbine is passed into cooling chamber	The exhaust gas from the turbine is exhausted to the atmosphere.	
		7	This system required more space.	This system required less space	
		8	Heat exchanger is used.	Heat exchanger is not used	
		9	Compressed air is heated in air heater	Compressed air is heated in combustion chamber	
		10	It is suited for stationary installation, marine use.	It is suited for moving vehicle.	
6	**e)**	**Discuss solar energy as non-conventional energy source.**			**4**
		(*Note: Credit should be given to equivalent answer)* Solar energy is very large , inexhaustible, readily available source of energy. From the sun we receive about 10^{14} Kw of energy which is 5 times greater than current used from all sources. So solar energy could supply all the present and future energy needs of the world on a continuing basis. In addition to this unlike conventional source it is an environmentally clean source of energy and it is free and available in adequate in almost all parts of the world. This makes it is one of the most promising of the non-conventional energy source.			**4**
6	**f)**	**Discuss CNG and LPG as gaseous fuels.**			**4**
		CNG-It is called as compressed natural gas. For transportation, storage and automotive use natural gas which is mainly composed of methane(CH_4) is compressed and stored in high pressure cylinder. CNG is used in traditional gasoline internal combustion engine cars that have been converted into bi-fuel vehicles(gasoline/CNG). It's Calorific Value is 46000 to 49000 KJ/kg. **LPG-** It is called as liquefied Petroleum Gas. It consist of butane, propane and exist in gaseous form under atmospheric condition but can be easily liquefied under pressure. It is used in domestic purpose as well as rural heating, Motor vehicle. It's Calorific Value is 46100 KJ/kg.			**2** **2**