



MODEL ANSWER

SUMMER- 17 EXAMINATION

Subject Title: Renewable Energy sources

17611

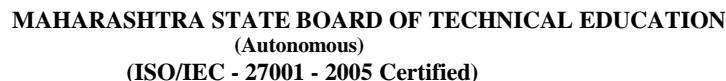
Subject

Code:

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. N.	Answer	Marking Scheme
1	A -a	<p>Need of alternate energy sources</p> <p>Because of the following reasons there is a need of developing, tapping, using the different alternate energy sources from future demand point of view..</p> <ol style="list-style-type: none">1. The supply of crude oil will fail to meet increasing demand.2. Demand for energy is continuously growing. To meet this alternate energy source is essential3. Coal reservoirs are unable to fulfill the energy demand4. Nuclear energy, hydroelectric energy, wind energy, solar energy sources are utilized but they are also unable to meet energy demand.5. India is blessed with a variety of renewable energy sources, the main ones being biomass, biogas, the sun, wind and small hydro power.6. Municipal and industrial wastes can also be useful sources of energy, but are basically different forms of biomass. Biogas plants, improved wood stoves, solar water heaters solar cookers, solar lanterns can be used at large.7. Different forms of biomass such as municipal and industrial wastes are the useful sources of energy. New technologies such as biogas plants improved wood stoves, solar water heater, solar cookers, solar lanterns, street lights; pumps wind electric	04

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2		is required to ensure that no individual cell goes overvoltage.	
	B -a	<p>Direct or beam radiation: Sunlight is the total spectrum of electromagnetic radiation given by the Sun. Solar radiation that has not been absorbed or scattered and reaches the ground directly from the Sun is called direct or beam radiation.</p> <p>Diffuse Solar radiation: It is that solar radiation received from the sun on the earth after its direction has been changed.</p> <p>Composition of solar radiations: Sun's radiation could be considered in two different aspects</p> <ol style="list-style-type: none">1. Terrestrial radiation2. Extra terrestrial radiation <p>Terrestrial radiation : It is the radiation, received on the earth's surface after the solar radiations have traversed through the layer of atmosphere.</p> <p>Extra terrestrial radiation : It is the radiation incident on a surface kept outside the atmosphere.</p>	02 02 02
	b	<p>Biodiesel Transesterification: Biodiesel is an alternative diesel fuel. Vegetable oil is too thick to flow through modern diesel engines without causing damage, so we can lower its viscosity through a process called Transesterification.</p> <p>Transesterification is the chemical process which replaces one type of alcohol for another in an ester. An ester is made by combining an alcohol with an acid.</p> <p>Vegetable oil is an ester of glycerol with long chain fatty acids. The formula for vegetable oil is $C_3H_5(RCOOH)_3$, with the fatty acids represented by $RCOOH$ attached to a glycerol ($C_3H_5(OH)_3$) molecule. Examples of fatty acids are Stearic acid, Palmitic acid, Linoleic acid, and Oleic acid. Methanol (CH_3OH) is used to replace glycerol ($C_3H_5(OH)_3$). A strong alkali is used as a catalyst to break apart the fatty acids from the glycerol. In commercial production we typically see Sodium Methoxide (CH_3NaO) dissolved in methanol used as the catalyst.</p> <p>The chemical formula for biodiesel transesterification is: $C_3H_5(RCOOH)_3 + 3CH_3OH \rightleftharpoons 3RCOCH_3O + C_3H_5(OH)_3$</p> <p>The biodiesel transesterification process is slightly reversible making it difficult to get 100% conversion. To push the reaction to its most complete status we use Le Chatelier's Principle and offset the reactants to drive the reaction in a more favorable direction.</p>	06
	a	<ol style="list-style-type: none">1) Declination angle (δ) : It is the angle between a line extending from the centre of the sun to the centre of the earth and the projection of this line upon the earth's equatorial plane.2) Hour Angle (ω) : The angle representing the position of the sun with respect	01 for each

to clock hour and with reference to sun's position at 12 noon is the hour angle .

3) Aaltitude angle (α): It is defined as the angle between the central ray from the sun , and a horizontal plane containing the observer is the Solar altitude angle. At the Sunrise and Sunset the solar altitude angle(α) is zero

4) Zenith Angle : If a vertical line is drawn to the horizontal plane at its centre the line joining sun and the centre of the plane will make an angle θ with this vertical . This angle is called the Zenith angle .

Parabolic trough collector:

These concentrating collectors are used in which the absorber is placed along the focus axis. In this the collector pipe is used as an absorber with a selective coating.

Parabolic reflectors are usually made of highly polished or silvered glass or of a film of aluminized plastic on affirm base. Instead of the reflector having a continuous form the reflector may be made of a large number of flat mirror strips on the parabolic firm base.

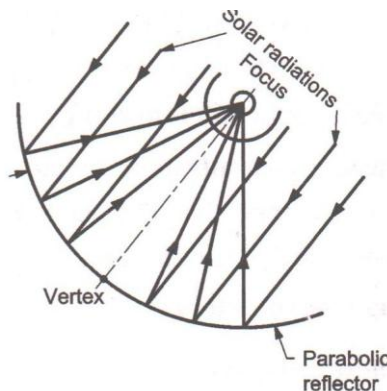


Fig-Parabolic concentrating solar collector

Heat Pipe-

The Heat Pipe comprises of three elements - a sealed container, a capillary wick structure and a working fluid. The capillary wick structure is integrally fabricated into the interior surface of the container tube and sealed under vacuum. Thermal energy applied to the external surface of the heat pipe is in equilibrium with its own vapour as the container tube is sealed under vacuum. Thermal energy applied to the external surface of the heat pipe causes the working fluid near the surface to evaporate instantaneously. Vapour thus formed absorbs the latent heat of vapourisation and this part of the heat pipe becomes an evaporator region. The vapour then travels to the other end the pipe where the thermal energy is removed causing the vapour to condense into liquid again, thereby giving up the latent heat of the condensation. This part of the heat pipe works as the condenser region. The condensed liquid then flows back to the evaporated region

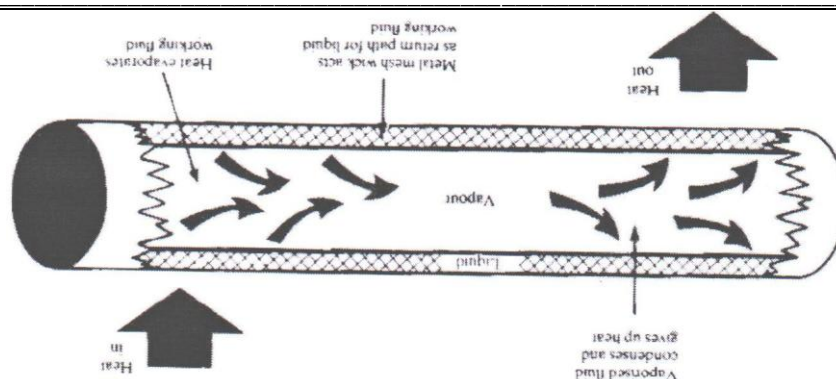


Fig-heat pipe

Principle of wind energy conversion: The wind energy is an indirect evidence of solar energy. The kinetic energy of the wind can be utilized to produce shaft power which is turn into electrical power by means of electric generator.

The total wind power is equal to the incoming kinetic energy of the wind stream. It can be expressed as ,

$$P_1 = \frac{1}{2} m C^2$$

The mass flow rate of air from continuity equation is ,

$$M = eAC$$

On substituting the value we, have,

$$P_1 = \frac{1}{2} e A C^2$$

The total wind power is defined as the total wind power per unit area of the wind stream .

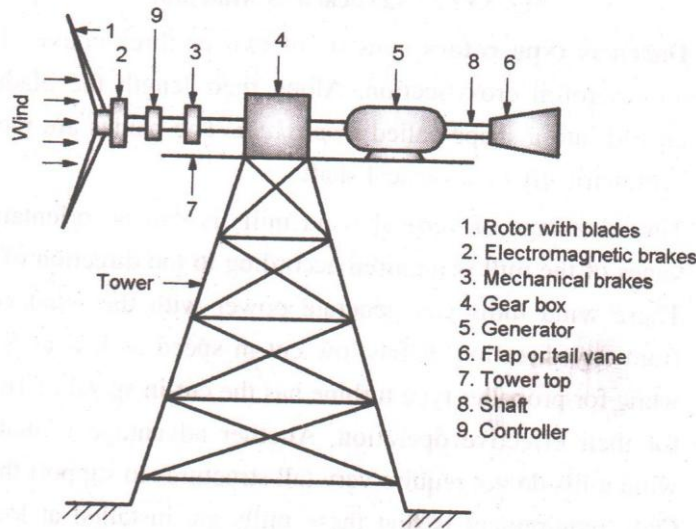
Energy Audit: An energy Audit is the first step in energy management programme. It shows how efficiently energy is being used and highlights opportunities for energy cost savings. It also shows ways to improve productivity.

Types of energy Audit :

1. Preliminary audit
2. Detailed Audit

Ways of improving boiler efficiency: Some of the ways to improve boiler efficiency are related to combustion process, to reduce the heat losses, reduction in power consumption. These are :

1. Control of Temperature of exhaust gases at entry to chimney and utilization of flue gases
 - a) Air preheater
 - b) Feed water heating in the economizer
2. Control of excess air to ensure complete combustion of fuel

3	a	<p>3. Reduction in radiation and convention heat losses 4. Control of steam pressure in boiler 5. Preheating combustion air 6. Reducing blow down 7. Stopping dynamic operation 8. Switching to lower cost fuel</p> <p>Principle of operation of hydro electric plant : In Hydro electric power plants the energy of water is utilized to move the hydraulic turbines which in turn runs an electric generator to convert the mechanical energy of turbine into electric energy. The rain water that flows on the earth's surface has potential energy relative to the ocean towards which it flows. In hydro electric power plants, the water is collected and artificially stored by constructing dams across the flowing stream. This potential energy of water is converted into mechanical work and ultimately into electrical energy.</p>	04
	b	<p>Working of Horizontal axis wind mill: The wind energy is converted into mechanical energy by aero turbine. this mechanical power is transmitted through gears to the generator to increase its speed . Since rotor speeds are low an overdrive is necessary to match the synchronous speed of the generator. The generator converts the mechanical power into electrical power.</p> <div data-bbox="506 1150 1198 1675">  </div> <p>Fig-Horizontal axis wind mill</p>	02
	c	<p>Energy plantation: There are certain plants which can be planted and harvested over regular period of time to have high yield per unit area. Thus the method of tapping maximum solar energy be growing plants on large scale is called energy plantation. Main plants proposed for energy plantation: Following plants are suitable for large</p>	02



4		scale plantation in Indian conditions having high yield a) Casuarina : These are suitable for plantation in coastal areas b) Eucalyptus : These are very fast growing trees. It grows to about 15m in three years c) Sorghums : These energy crop is suitable for alcohol production d) Other suitable trees : These are babool, Leucaena, Jajoba etc	02
	d	Anaerobic digestion: Anaerobic digestion is a biochemical process in which the particular kinds of bacteria digest biomass in an oxygen free environment. The process of anaerobic digestion occurs in a sequence of stages involving distinct types of bacteria. Hydrolytic and fermentative bacteria first break down the carbohydrates, proteins and fats present in biomass feedstock into fatty acids, carbon dioxide, hydrogen, ammonia and sulfides. This stage is called hydrolysis Next, acetogenic bacteria further digest the products of hydrolysis into acetic acid, hydrogen and carbon dioxide. Methanogenic bacteria then convert these products into biogas. The combustion of digester gas can supply useful energy in the form of hot air, hot water or steam. After filtering and drying, digester gas is suitable as a fuel for an I.C. engine, which combined with generator, can produce electricity.+	04
	e	Energy management :The judicious and effective use of energy so as to reduce the energy requirements per unit output OR the optimization and effective use of energy so as to produce goods at least cost and competitive prices Objectives of energy management : 1. To reduce energy consumption 2. To minimize energy cost 3. Reduce waste of energy 4. Adopt new technology requiring low energy consumption 5. Reduce emission so as minimize environmental effects.	02 02
	a	Global Warming: It is also called as climate change. It refers to the long term fluctuations in temperature, precipitation, wind and earth elements of the earth climate system. Greenhouse effect : Carbondioxide produced by power plants has no ill effect on human life but increase concentration of CO ₂ leads to climate change, it increases heat trapping quality leading to green house effect. Heating of earths atmosphere due to this trapping is due to long wavelength infrared radiations by the CO ₂ layer in the atmosphere. This effect is used in	02

growing the green plants in an enclosure made of glass and other transparent material so that heat is trapped in cold atmosphere even.

02

b

Sources of renewable energy :

- Solar energy
- Wind energy
- Tidal energy
- Geothermal energy
- Bio mass energy

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(Explain any one of the above source in proper words)

02

c

SPV Pumping system :

Solar pump system : Solar pumping consists of power generated by solar energy for water pumping useful for irrigation.

The basic system consists of following components:

1. Solar panels/Arrays
2. Charging and circuit
3. Pumps
4. Water storage systems

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Solar pumps works with the help of solar photo voltaic (SPV) panels. They convert solar energy directly to electrical energy without having to go through any thermal or mechanical processes. This reduces the losses considerably and improves efficiency.

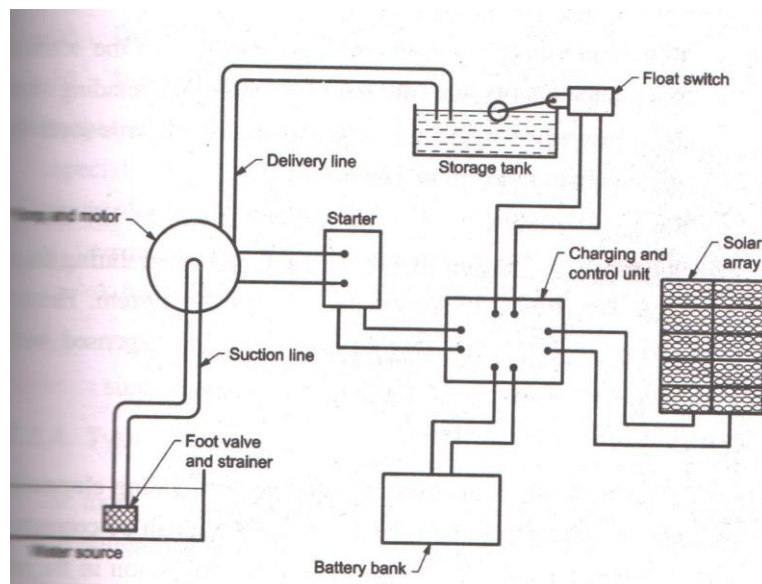
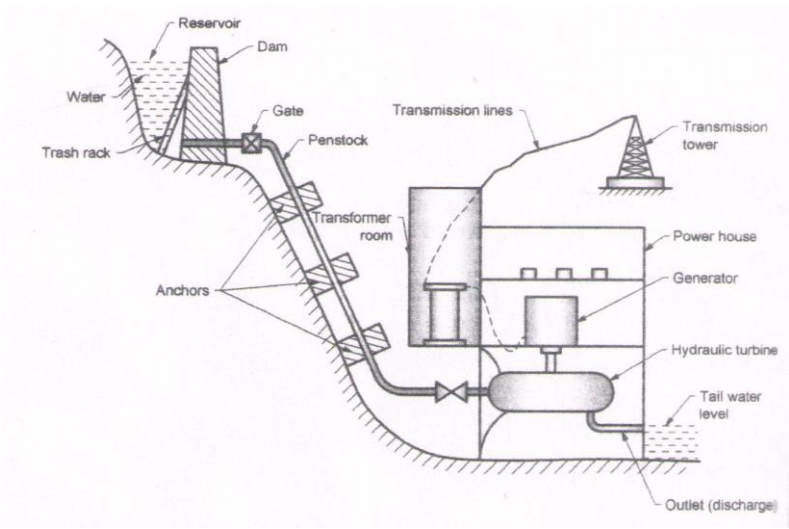


Fig- SPV Pumping system

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<p>d</p> <p>B -a</p>	<p>Points for site selection of small hydro electric power plant</p> <ol style="list-style-type: none"> 1. Water availability and method of storage 2. Availability of head 3. Distance of power station from power demand centre 4. Availability of construction materials 5. Access to site, 6. Availability of transport facilities etc 7. Availability of labour power 8. Heavy rain fall area <p>Small hydroelectric power plant:</p>  <p>Fig-Small hydroelectric power plant</p> <p>A small hydro electric power plant consists of the following :</p> <ol style="list-style-type: none"> 1. Reservoir : used to store water during rainy season. This water is used to run the hydraulic turbine 2. Dam : It is a structure of considerable height built across the river. It provides working head of water for power plant 3. Gate : It is provided for controlling of flow of water from reservoir to turbine 4. Waterway and penstock: Waterway carries water from the dm to the power house. It includes canal and penstock or tunnel 	<p>01 for each Any four</p> <p>03</p> <p>03</p>
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5. Hydraulic turbine: These are used to convert the kinetic energy of water into mechanical energy

b

Solar Photovoltaic electric conversion :

A pair of positive and negative charges called electron hole pairs are created in the solar cells by absorbed solar radiations. The suitable materials for absorbing the energy of photons of sunlight are semi conductors like silicon, gallium with dopants. In a semi conductor the valence band has electrons at lower level of energy which is fully occupied . The difference in minimum energy of electrons in conductor band and the maximum energy of electrons in the valence band is called band gap energy. When solar radiation fall, the difference of photon energy of sun light and the band gap energy are absorbed by the cell material . These electrons in the conduction band and holes in the valence band can be made to flow in an external circuit if the potential difference exists within the cell.

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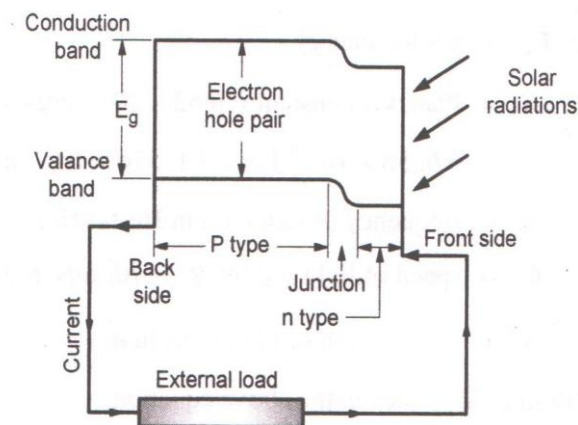


Fig- Solar Photovoltaic electric conversion

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a

Thermochemical conversion of bio mass :

The thermochemical reactions can convert the organic biomass into more valuable and convenient form of products as gaseous and liquid fuels, residues and by-products etc at different pressures and temperatures. These processes can be carried out in the following methods,

02

02

1. Gasification
2. Pyrolysis

04

b

Species for biomass:

- Sugarcane
- Canola oil
- Willows
- Forest residues
- Agriculture residue
- Bearing plants

Biomass is produced in the photosynthesis process which converts the solar energy into biomass energy. Photosynthesis process only occurs in the green plants. It is the process of

combining the CO₂ from the atmosphere with water plus light energy to produce carbohydrates (Sugar , starches, celluloses etc) and oxygen

Sunshine recorder :

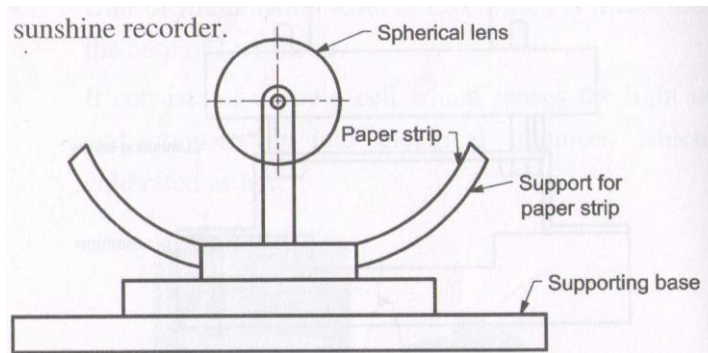


Fig- Sunshine recorder

Purpose of sunshine recorder :

A sunshine recorder is a device that records the amount of sunshine at a given location. The results provide information about the weather and climate as well as the temperature of a geographical area. This information is useful in meteorology, science, agriculture, tourism, and other fields. It has also been called a heliograph.

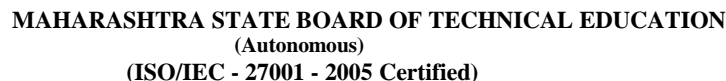
There are two basic types of sunshine recorders. One type uses the sun itself as a time-scale for the sunshine readings. The other type uses some form of clock for the time scale.

Principle and Construction:

A Campbell-Stokes sunshine recorder concentrates sunlight through a glass sphere onto a recording card placed at its focal point. The length of the burn trace left on the card represents the sunshine duration. A homogeneous transparent glass sphere L is supported on an arc XY, and is focused so that an image of the sun is formed on recording paper placed in a metal bowl FF' attached to the arc. The glass sphere is concentric to this bowl, which has three partially overlapping grooves into which recording cards for use in the summer, winter or spring and autumn are set.

Three different recording cards are used depending on the season. The focus shifts as the sun moves, and a burn trace is left on the recording card at the focal point. A burn trace at a particular point indicates the presence of sunshine at that time, and the recording card is scaled with hour marks so that the exact time of sunshine occurrence can be ascertained. Measuring the overall length of burn traces reveals the sunshine duration for that day. For exact measurement, the sunshine recorder must be accurately adjusted for planar levelling, meridional direction and latitude.

Energy Audit help to industries: The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programmes which are vital for production and utility activities. Such an audit programme will

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(iii) High-head hydro electricplants : "High head" power plants are the most common and generally utilize a dam to store water at an increased elevation. The use of a dam to impound water also provides the capability of storing water during rainy periods and releasing it during dry periods.

The classification according to nature of load is

(i) Base load plants : A base load power plant is one that provides a steady flow of power regardless of total power demand by the grid. These plants run at all times through the year.

(ii) Peak load plants : Power plants for electricity generation which, due to their operational and economic properties, are used to cover the peak load. Gas turbines and storage and pumped storage power plants are used as peak load power plants. The efficiency of such plants is around 60 -70%.

Solar cooker

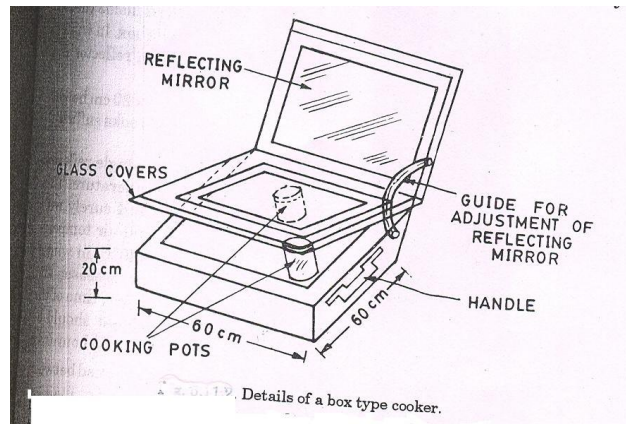
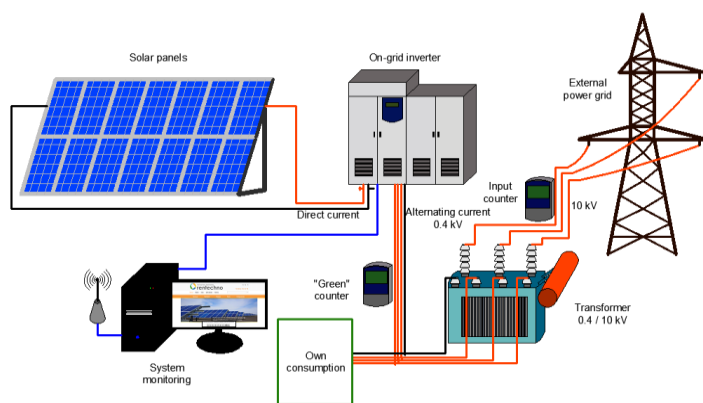
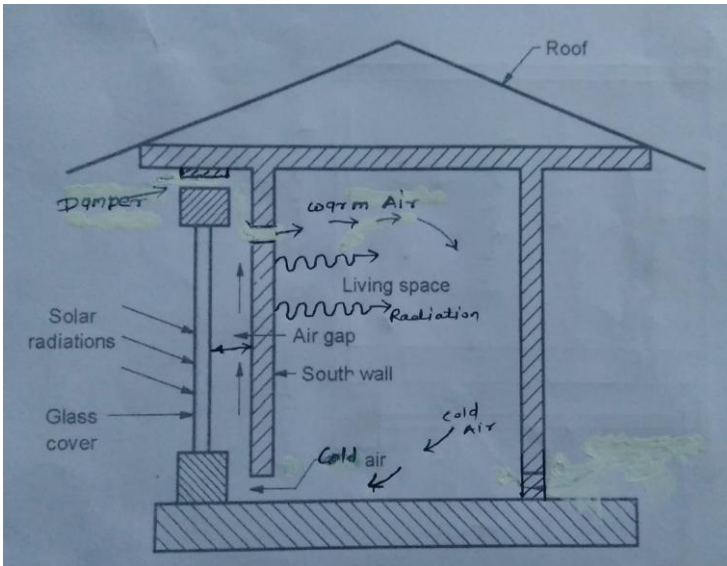


Fig-solar cooker

Figure shows the box type solar cooker. The solar rays penetrate through the glass covers and absorbed by a blackened metal tray kept inside the solar box. Two glass covers are provided to again minimize the heat loss. The loss due to convection is minimized by making the box air tight by providing a rubber strip all rounds between the upper lid and the box. When the cooker is placed in the sun, the blackened surface starts absorbing sun rays and temperature inside the box starts rising. The blackened cooking pots get heat energy and food will be cooked in a period of time.

b	<p>Solar PV system :</p> <p>Advantages :</p> <ol style="list-style-type: none"> 1. It converts solar energy directly to electrical energy 2. Solar cells are reliable, modular, durable and maintenance free 3. Compatible with environment 4. Can be installed at the place of utility 5. More long lasting for a period of more than 20 years 6. Flexibility in power capacities is more <p>Disadvantages :</p> <ol style="list-style-type: none"> 1. Conversion efficiency are very low 2. Larger area is needed to generate sufficient power 3. Very costly material of solar material 4. Intermittent energy is obtained 	02
c	<p>Principles of photovoltaic power generation: Photovoltaic plants consist of photovoltaic cells which work based on the photovoltaic effect. In photovoltaic effect, two dissimilar materials (like silicon and germanium) are put in close contact. When exposed to radiation, electrons from one material absorb the photons, get excited and jump to the other material. This movement of electrons induces positive charge in one material and negative in the other resulting in generation of electro motive force. In a solar power plant, an array of solar cells is created (in series and parallel with each other) to produce desired current and voltage level.</p> <p>Figure shows the solar power plant . it consists of a solar panel which collects the sun radiations and it converts these radiation in d.c. current which is controlled by a monitoring unit . This current is supplied to on grid invertors and finally to the grid</p> <div data-bbox="527 1302 1226 1701" data-label="Diagram">  </div> <p style="text-align: center;">Fig- Photovoltaic power generation</p>	02

<p>d</p>	<p>Space heating by passive method.(02 marks for sketch, 02 marks for explanation)</p> <p>Space heating: A solar space heating can consist of a passive system, an active system or combination of both. Passive systems are typically less costly and less complex than active system. Passive solar space heating takes advantage of warmth from the sun through design features such as large south facing windows and materials in the floors or walls that absorb warmth during the day. A sunspace or greenhouse is a good example of passive system for solar space heating</p>  <p>Fig- Space heating by passive method</p>	<p>02</p> <p>02</p>
<p>e</p>	<p>Parameters of site selection of wind mill:</p> <ol style="list-style-type: none"> 1) Availability of higher constant wind speed 2) Availability of wind at site through year 3) Altitude of the site 4) Availability of land 5) Connectivity to grid 6) Connectivity to the road 7) Easy access to locality/infrastructure 8) Ecology 9) Ground condition 	<p>01 for each any four</p>



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