



MODEL ANSWER

WINTER - 2018 EXAMINATION

Subject Title: Renewable Energy sources

Subject Code: **17611**

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	<p>Explain the necessity of renewable energy</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



generators biomass gasifiers are becoming commercially available.

In view of the above, we need to reduce our dependency on oil, coal and nuclear fuels and their imports. Therefore we need to increase our oil and gas production and look for alternate sources energy for our power needs.

b Explain the consequences of global warming

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 :

Carbon dioxide produced by power plants has no ill effect on human life but increase concentration of CO₂ 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 CO₂ layer in the atmosphere. This effect is used in growing the green plants in an enclosure made of glass and other transparent material so that heat is trapped in cold atmosphere even.

The effects of global warming have taken its role on people, animals, birds and habitat. In fact no continent has been spared.

Developing countries are twice as at risk to climate change as industrialized countries, and small islands states are thrice as at risk

Estimates drawn from reports by the Intergovernmental Panel on Climate Changes (IPCC) projects increase in average global temperatures ranging from 1.4 0C to 5.8 0C

04

c

Classify small hydroelectric plants

Classifications of hydro electric power plant :

The classification according to **Quantity of water** available is

(i) Run-off river plants without pondage : These plants does not store water; the plant uses water as it comes. The plant can use water as and when available.

(ii) Run-off river plants with pondage : In these plants pondage permits storage of water during off peak periods and use of this water during peak periods. Depending on the size of pondage provided it may be possible to cope with hour to hour fluctuations.

(iii) Reservoir Plants :A reservoir plant is that which has a reservoir of such size as to permit carrying over storage from wet season to the next dry season.Water is stored behind the dam and is available to the plant with control as required.

The classification according to availability of **water head** is

04



(i) Low-Head (less than 30 meters) Hydro electricplants :”Low head” hydro-electric plants are power plants which generally utilize heads of only a few meters or less.

(ii) Medium-head(30 meters – 300 meters) hydro electricplants :These plants consist of a large dam in a mountainous area which creates a huge reservoir.

(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%.

d

Explain the desirable features of bioethanol that makes it suitable automobile fuel

Desirable features of bioethanol that makes it suitable automobile fuel are :-

1. Pure ethanol is a flammable, colorless liquid with a boiling point of 78.5° C.
2. Its low melting point of -114.5° C allows it to be used in antifreeze products.
3. Its density is 789 gms/litre.
4. It reduces greenhouse gas emissions by up to 59 percent relative to gasoline.
5. Ethanol also burns more cleanly and completely than gasoline or diesel fuel.
6. As a renewable fuel, ethanol is doing more for the environment.

04

e

Define energy audit and discuss why energy audit is necessary

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

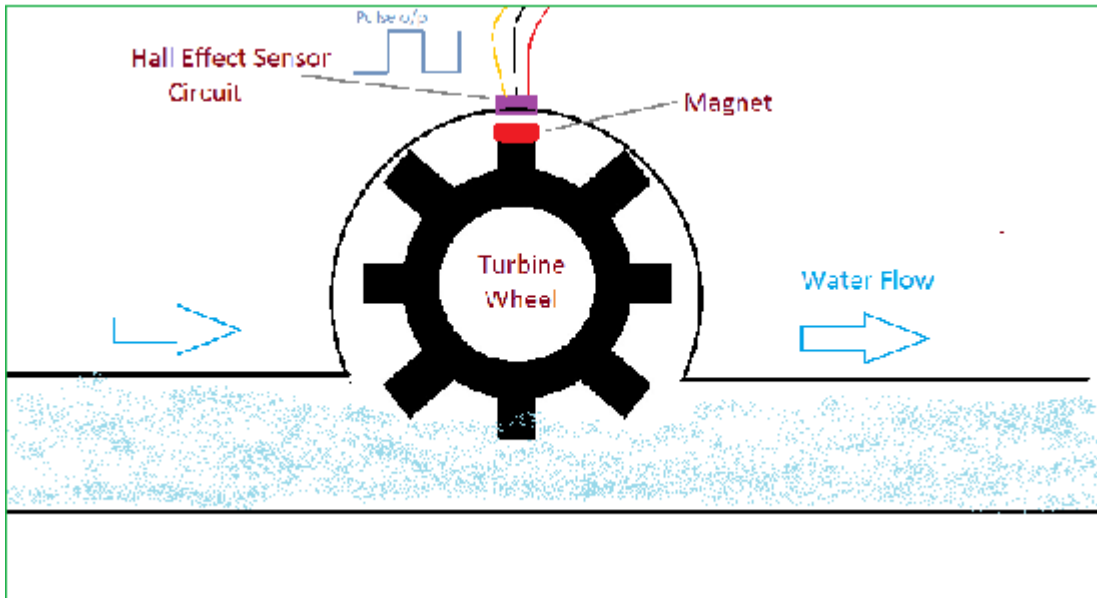
Necessity of Energy Audit : Energy audit takes a thorough look at a particular facilities, process or technologies. A compressive audit provides a detailed energy project implementation plan for a facility. This type of audit offers the most accurate estimate of energy savings and cost

04

f

Draw a labeled sketch of water flow meter

04



g

Define

- i) Boiler efficiency
- ii) Furnace efficiency

$$\text{Boiler Efficiency} = \frac{\text{Heat Output}}{\text{Heat Input}} \times 100$$

$$\text{Boiler Efficiency} = \frac{\text{Steam flow rate} \times (\text{steam enthalpy} - \text{feed water enthalpy})}{\text{Fuel firing rate} \times \text{Gross calorific value}} \times 100$$

Let

- m_s = Rate of steam generated kg per hour
- h_1 = Enthalpy of steam at the exit of boiler in kJ/kg
- h_2 = Entahlpy of feed water in
- m_f = rate of fuel consumed in kg / hr
- G.C.V. = Gross calorific Value in kJ/ kg
- $\eta = m_s(h_1 - h_2) / m_f \times \text{G.C.V}$

Furnace efficiency is calculated as

$$\text{Furnace efficiency} = \frac{\text{Heat Output}}{\text{Heat Input}} \times 100$$

$$\text{Furnace efficiency} = \frac{\text{Heat in stock (kJ)}}{\text{Heat in Fuel (kJ)}} \times 100$$

02

Marks
each



2	a	<p>Explain the features of latent heat storage</p> <p>In latent heat storage, the material stores heat while changing phase. The main characteristic of this technology is that during the phase change the materials remain, theoretically, at constant temperature (real systems show temperature stabilization around the melting temperature).</p> <p>Phase Change Materials (PCM) are latent heat storage materials. As the source temperature rises, the chemical bonds within the PCM break up as the material changes phase from solid to liquid (as is the case for solid-liquid PCMs). ... Latent heat storage can be used in a wide temperature range.</p>	04
	b	<p>Define</p> <p>(i) Hour Angle (ω) : The angle representing the position of the sun with respect to clock hour and with reference to sun's position at 12 noon is the hour angle .</p> <p>(ii) Declination (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.</p> <p>(iii) 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.</p> <p>(iv) Inclination angle (θ) The solar incidence angle is the angle between the Sun's rays and an imaginary perpendicular to a collector's surface .</p>	01 for each
	c	<p>What is solar spectrum? Discuss it.</p> <p>The sun radiates solar energy or sunlight by electromagnetic waves over a range of wavelengths known as the Solar Spectrum.</p> <p>The solar spectrum is divided into three bands.</p> <p>Ultraviolet, Visible (PAR), and Infrared of the light.</p> <p>The solar light that reaches Earth's surface, infrared radiation makes up 49.4% of while visible light provides 42.3% 9. Ultraviolet radiation makes up just over 8% of the total solar radiation.</p>	04

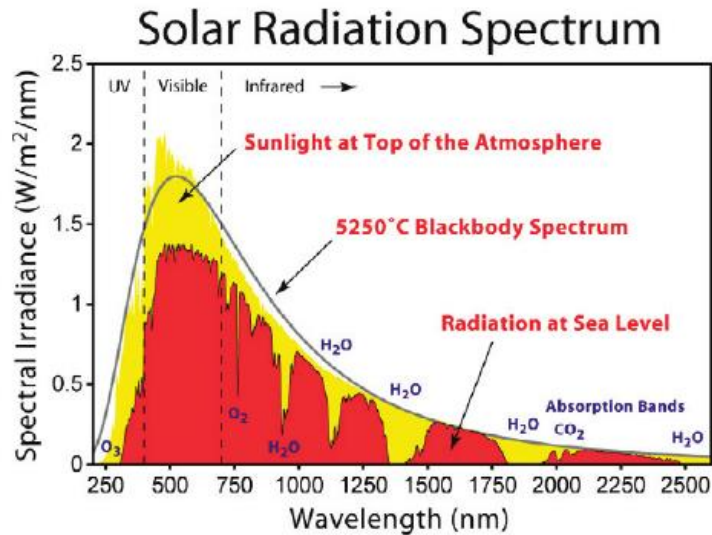


Figure not compulsory

Explain the principle of wind energy conversion

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 ,

$$M = e A C$$

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.

What are the most favorable sites for installing of wind turbines?

Following factors are to be considered to select most favorable sites for installing wind turbines.

- 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

04

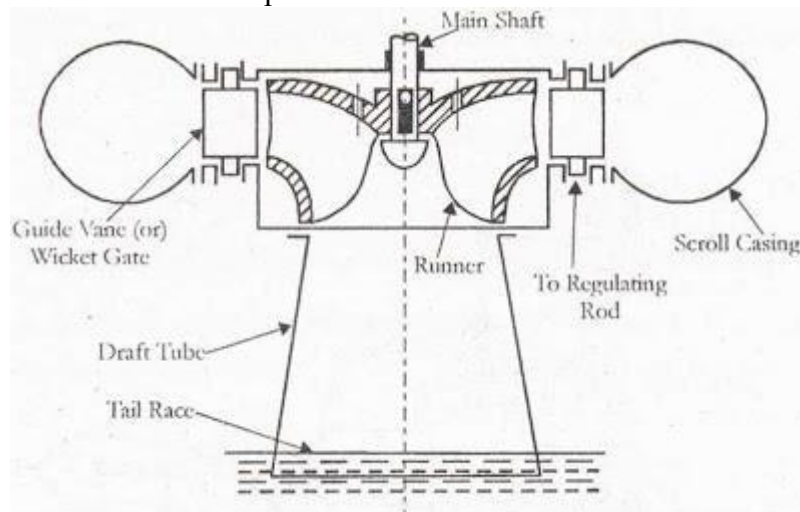
How energy loss is prevented with thermal insulation?

Most common insulation materials work by slowing conductive heat flow and--to a lesser extent--convective heat flow. Radiant barriers and reflective insulation systems work by reducing radiant heat gain. To be effective, the reflective surface must face an air space.

Explain with neat sketch construction and working of Francis Turbine.

Construction and Working of Francis Turbine:-

In Francis Turbine water flow is radial into the turbine and exits the Turbine axially. Water pressure decreases as it passes through the turbine imparting reaction on the turbine blades making the turbine rotate. Francis Turbine has a circular plate fixed to the rotating shaft perpendicular to its surface and passing through its center. This circular plate has curved channels on it; the plate with channels is collectively called as runner. The runner is encircled by a ring of stationary channels called as guide vanes. Guide vanes are housed in a spiral casing called as volute. The exit of the Francis turbine is at the center of the runner plate. There is a draft tube attached to the central exit of the runner. Francis Turbines are generally installed with their axis vertical. Water with high head (pressure) enters the turbine through the spiral casing surrounding the guide vanes. The water loses a part of its pressure in the volute (spiral casing) to maintain its speed. Then water passes through guide vanes where it is directed to strike the blades on the runner at optimum angles. As the water flows through the runner its pressure and angular momentum reduces. This reduction imparts reaction on the runner and power is transferred to the turbine shaft.



04

3

b

Explain with neat sketch Solar photovoltaic pumping.

A Solar photovoltaic pumping system is an electrically driven pumping system. Electricity is produced by the sunlight emerging photovoltaic modules. When the sun energy falls on the solar cell, the cell produces DC current and for constant load solar charge controller is used. The DC electrical energy is stored in battery and battery is connected to pumping system.

A Solar photovoltaic pumping system consists,

1. Solar panels- It is the basic power source of a solar pumping system. The basic element of the panel is the solar cell.
2. Charging and control circuit - Its function is to ensure that when the electricity produced by the solar panel is sufficiently high, it charges the battery.
3. Pumps- The most commonly used water pumps are centrifugal pumps.
4. Water storage system - The pump is running and pumping water to a storage tank.

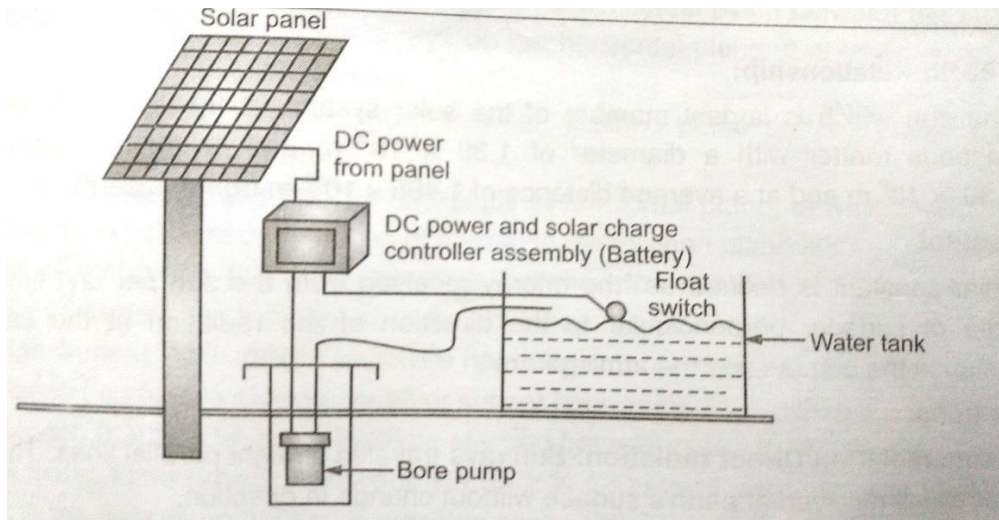


Fig- Solar photovoltaic pumping system

3

C (i)

Explain the principle of tidal energy

Tide or wave is periodic rise and fall of water level of the sea. Tides occur due to the attraction of sea water by the moon. Tides contain large amount of potential energy which is used for power generation. When the water is above the mean sea level, it is called flood tide. When the water level is below the mean level it is called ebb tide.

ii

What are the merits and demerits of geothermal energy?

Geothermal Energy Advantages (Any four)

- 1) It is a renewable source of energy.
- 2) By far, it is non-polluting and environment friendly.

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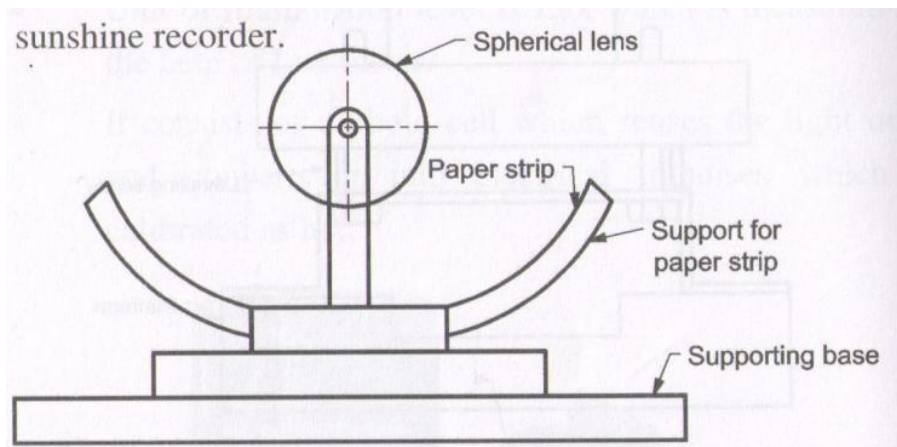
- 3) There is no wastage or generation of by-products.
- 4) Geothermal energy can be used directly. In ancient times, people used this source of energy for heating homes, cooking, etc.
- 5) Maintenance cost of geothermal power plants is very less.
- 6) Geothermal power plants don't occupy too much space and thus help in protecting natural environment.
- 7) Unlike solar energy, it is not dependent on the weather conditions

Disadvantages of Geothermal Energy (Any Four)

- 1) Only few sites have the potential of Geothermal Energy.
- 2) Most of the sites, where geothermal energy is produced, are far from markets or cities, where it needs to be consumed.
- 3) Total generation potential of this source is too small.
- 4) There is always a danger of eruption of volcano.
- 5) Installation cost of steam power plant is very high.
- 6) There is no guarantee that the amount of energy which is produced will justify the capital expenditure and operations costs.
- 7) It may release some harmful, poisonous gases that can escape through the holes

02

4 a Explain with figure 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.

02

02

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.

04

State the advantages of anaerobic digestion.

b

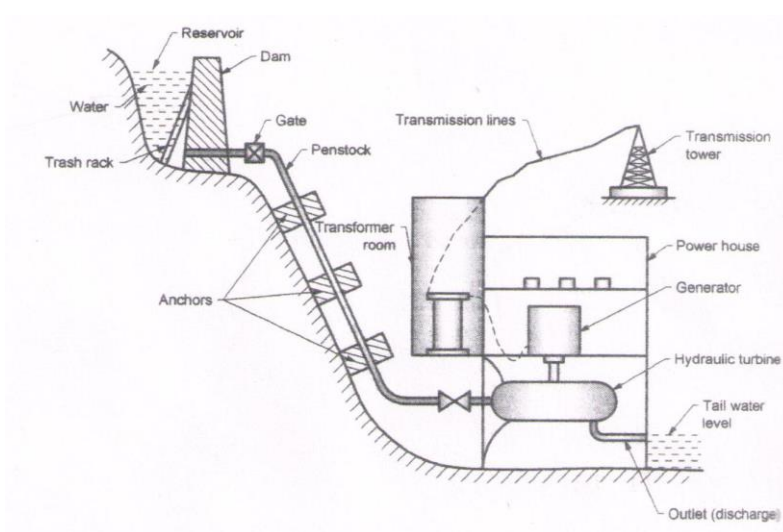
Following are the advantages of anaerobic digestion

1. It is a net energy producing process which produces renewable energy in the form of biogas.
2. It produces a liquid and a fibrous fertilizer.
3. It sanitizes the feedstock/ waste which is put through it, as long as the temperature is held above a required temperature for a pre-defined time period.
4. It reduces odour below unprocessed waste odour levels.
5. It is much less likely to cause environmental pollution than spreading untreated organic waste on land.
6. The effect of the fertilizer is longer lasting than for untreated organic waste.

04

Draw a typical layout of micro hydro power plant

c



d **What are green house gases?** 02

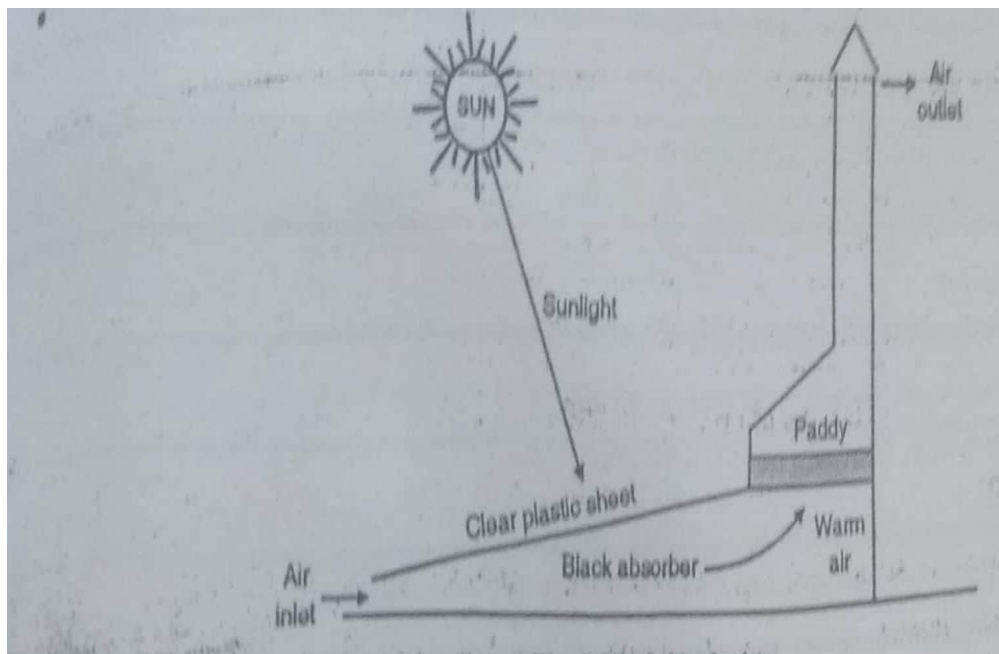
A greenhouse gas is any gaseous compound in the atmosphere that is capable of absorbing infrared radiation, thereby trapping and holding heat in the atmosphere. By increasing the heat in the atmosphere, greenhouse gases are responsible for the greenhouse effect, which ultimately leads to global warming.

Carbon dioxide (CO₂). Accounts for around three-quarters of the warming impact of current human greenhouse-gas emissions. The key source of CO₂ is the burning of fossil fuels such as coal, oil and gas, though deforestation is also a very significant contributor. Methane (CH₄).

Major Greenhouse Gases. Many GHGs, including water vapor (the most important), ozone, carbon dioxide, methane, and nitrous oxide, are naturally present in the atmosphere. Other GHGs are synthetic chemicals that are emitted only as a result of human activity.

e **With the help of schematic diagram explain the working of solar dryer.** 02

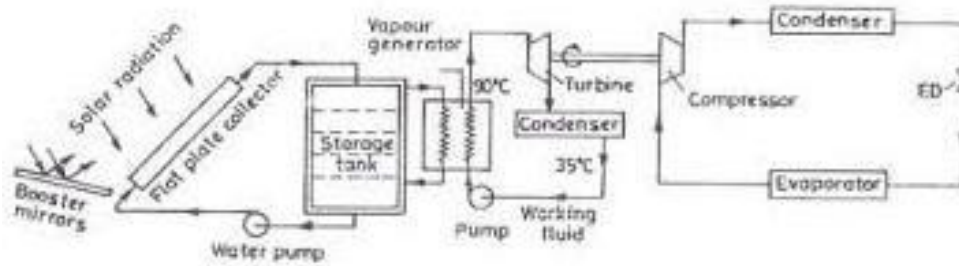
A typical air based drying system using solar thermal energy often combined with bio heat is shown in the figure. the intake air from biomass boiler is heated in the solar collector are made up of a glazed or unglazed air collectors. Since the system is quite simple and there is no storage needed



02

f **Explain with figure solar refrigeration.**

A Solar powered compression refrigeration system is shown in figure. It consists of mainly solar collector and storage tank for heat exchange in the exchanger. The turbine power is used to run the compressor of usual VCR system. It is to be noted that there is no requirement of external electrical power supply to the compressor as it is given by the turbine running on solar energy.

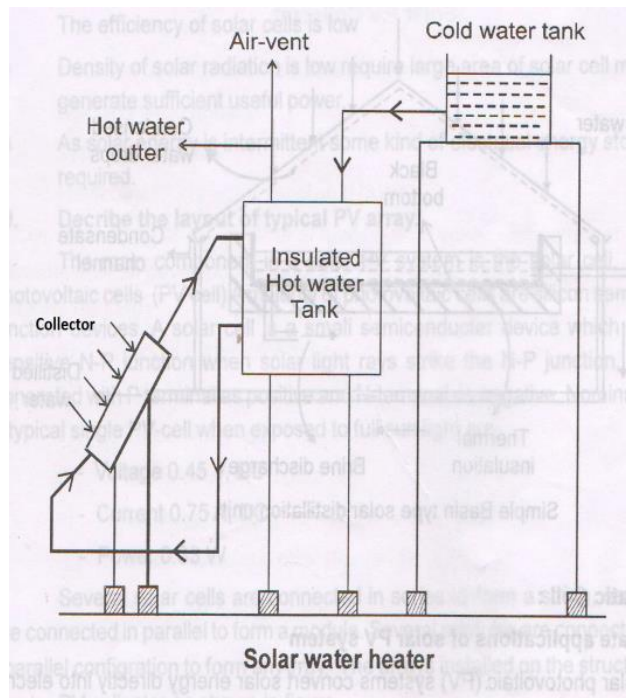


5

a **Explain with diagram solar water heating system.**

A tilted flat plate solar collector with water as heat transfer fluid is used in solar water heater system. A thermally insulated hot water storage tank is mounted above the collector. The heated water of the collector rises up to the hot water tank and equal quantity of cold water enters the collector. The cycle repeats, resulting in all the water of the hot water tank getting heated up. When water is taken out from hot water outlet, the same is replaced by cold water from cold water tank, fixed above the hot water tank.

Advantages : It does not require any pumping system
It can be used with auxiliary heating system



b **Solar photovoltaic energy conversion** 04

Photovoltaic energy conversion: It is the process in which solar energy is converted into electrical energy. When photon is absorbed, its energy is given to an electron in the crystal lattice. The energy given to this valence bond excites it into the conduction band.

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.

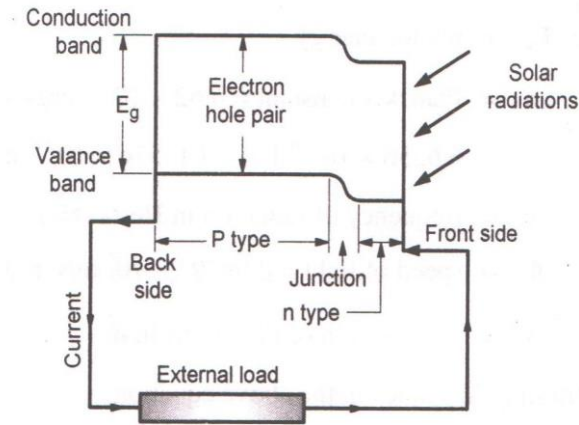


Fig- Photovoltaic energy conversion

c (i) (i) **Lift:** 02

FL which is normal to the direction of approach velocity. It is responsible for an aeroplane to maintain its lift. It is caused due to unbalanced pressure distribution over aerofoil surface.

(ii) **Drag:** 02

FD which is parallel to the direction of approach velocity. It represents the friction forces. Lift is useful component which gives rotation to the turbine.

d **Factors to be considered for Erection of hydroelectric power plant** 04

1. Physical Factors:

The following physical conditions are necessary for the construction and success of hydro-electric plants:

- (i) Regular and abundant supply of water or quantity of water;
- (ii) Rugged topography or degree of slope;
- (iii) Existence of rapids and waterfalls;



- (iv) Solid rock structure or geological stability for construction of dams;
- (v) Suitable climate, i.e., temperature above freezing point;
- (vi) Presence of lakes; and
- (vii) Silt-free water, etc.

2. Economic Factors:

Economic factors play an important role in the development of hydro-electric power.

These factors are as follows:

- (i) Demand of power:
- (ii) Lack of other energy sources:
- (iii) Capital investment:
- (iv) Other factors:

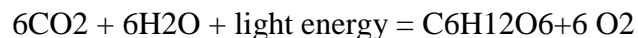
Among other economic factors:

- (a) Location of industrial and commercial centres,
- (b) Improved modern technology, and
- (c) Transport and communication are important.

e

Describe the process of photosynthesis

Photosynthesis: It is the process in which solar energy is converted into biomass energy. Photosynthesis process occurs only in green plants. It is the process of combining CO₂ from the atmosphere with water in the presence of light energy to produce carbohydrates and oxygen. The photosynthesis process is complex but overall photosynthesis process can be represented by the following process



Total energy stored in the photosynthesis process is about 4500 kJ

04

f

What do you understand by energy plantation?

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 by growing plants on large scale is called energy plantation.

Advantages

- a) Virtually there is no maintenance
- b) It is economical
- c) It is non polluting
- d) It acts as a best solar collector

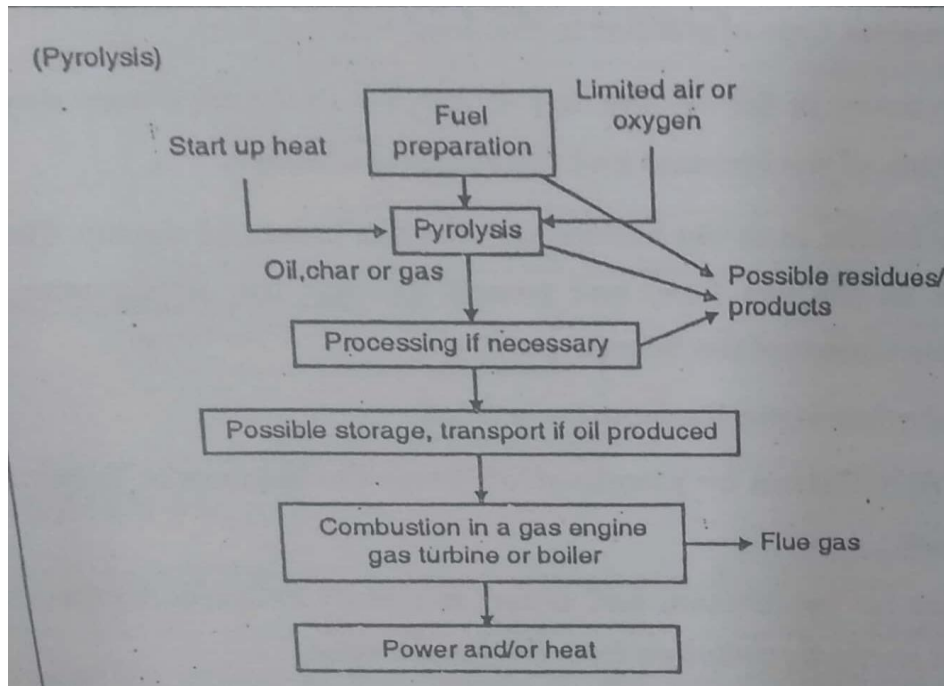
04

6

a

Pyrolysis: It is the heating of biomass in a closed vessel at temperatures in the range of 500 ° C to 900 ° C in absence of O₂/ air or with steam. It produces solid, liquid and gases. This process can use all type of organic materials including plastic and rubbers.

08



b

Describe in detail, preliminary energy audit methodology.

04

Detailed Energy Audit Methodology: It is a comprehensive analysis of an energy project and offers the accurate estimate of energy savings and cost. It covers the detailed study of present energy consumption, the use of energy for various processes with calculations of energy efficiency and to evaluate the improvements which can be carried out in its energy use. Detailed audit finally recommends the energy conservation proposals with cost of investment needed. It also presents the detailed study of expected savings in energy cost.

04

The detailed energy audit report consists of the following :

1. Details about plant
2. Description of production processes involved
3. Description of energy and utility system
4. Detailed process flow diagram and energy
5. Calculation of energy efficiency and process systems
6. Recommendations for energy conservation

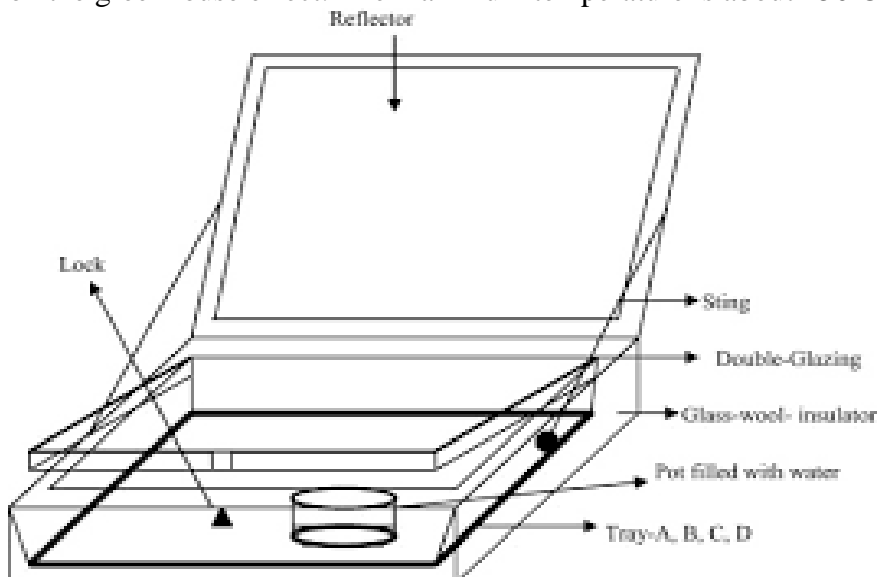
C

(i) How does solar powered traffic signal work ?

Most solar traffic lights use LED lamps as they are more reliable and have more advantages over other lighting devices like CFL lamps as they are more energy efficient, have a longer life span and turn on and turn off quickly. Solar traffic lights contain enclosures which house the batteries and the control panel circuitry. Existing traffic lights can also be upgraded with an auxiliary power source using solar panels for use during power failures. The other parts in a solar traffic light include a charge controller to control the charging and discharging of the battery and a countdown timer which displays the amount of time left before the battery discharges fully.

(ii) Draw a well labelled diagram of Box type solar cooker.

A box type solar cooker consists of an insulated box with a transparent cover made of glass or plastic. Usually the box also includes one or more adjustable external flat reflectors ("boosters") in order to enhance solar radiation into the cooker. The operation of a solar box cooker is based on the greenhouse effect. The maximum temperature is about 150 C.



04

02

02