Sources of Energy

Physics – X CBSE

Introduction

We need energy for doing work. There are many types of works and so there are different types of energy. Energy becomes an essential part of our everyday active life. We have leant about the various forms of energy and we know these different forms are intercom vertible. We shall now learn about different sources of energy and group them according to the manner in which they supply energy.

- **Characteristics (Factors Constituting a Source of Energy)**
  1. It should be capable of providing an adequate amount of energy.
  2. It should be convenient to use, easy to transport and store.
  3. It should be capable of delivering desired quantity of energy at a steady rate over a long period of time.

  Home requirement

  In homes, besides carrying life activities, we mostly use fuels and electricity for heating, lighting and operating machines and other appliances.

Conventional and Non-conventional Sources of Energy

Sources of energy are also classified as:

1. **Conventional sources of energy**
   The sources which are used extensively since ancient times and major portion of our energy requirement are met by them e.g., fossil fuels and hydro energy are known as conventional sources of energy. Biomass energy and wind energy also are conventional sources of energy.
2. **Non-Conventional sources of energy**
   The sources which are not used extensively i.e., are limited in use are called non-conventional sources. For example. Solar energy, sea energy, geothermal energy and nuclear energy. These are called as alternative sources of energy.

Fossil Fuels

The combustible substances formed from the dead remains of the animals and plants which were buried deep under the surface of the earth over millions of years are called fossil energy sources or fossil fuels. At present, a major part of our energy requirement is being supplied by fossil fuels. Example of Fossil Fuels: Coal, petroleum and natural gas.

- **Coal**
  1. **Description:** Coal is a naturally occurring black mineral. It is a mixture of free carbon and carbon compounds containing hydrogen, nitrogen, oxygen and sulphur. It is not only a good fuel but also source of many organic compound.
  2. **Formation:** Coal is believed to be formed from fossils of big trees which got buried inside the earth about 300 million years ago due to occurance of earthquakes and eruption of volcanoes.
  3. **Procurement (Mining):** The coal is procured from coal mines. Minerable coal is defined as 50% of all coal which is in a layer of at least 12 inches thick and within 4000 feet of the surface.
  4. **Varieties:** There are four varieties of coals classified on the basis of carbon contents.

Name	Carbon
(i) Peat	27%
(ii) Lignite	28-30%
(iii) Bituminous	78 — 87%
(iv) Anthracite	94 - 98%

     Coal with higher carbon content delivers more energy. It makes Anthracite as the best quality coal.
  5. Releases of Energy: When the coal is burnt, the carbon present in it reacts with oxygen to produce carbon dioxide. A lot of heat is also produced because the reaction is exothermic.

ILLUSTRATION

1. One gram of coal on complete combustion liberates 18 kj of heat. Calculate the amount of coal required to liberate the same amount of heat that an electric heater of 2kw provides in one hour.

Soln. $p = \frac{E}{t} \therefore E = p \times t = (2kw)(3600_s)$

$\therefore \quad E = 7200KJ$

18 KJ of heat is liberated on burning 1g of coal

$\therefore$ 72000 KJ of heat is liberated by burning

$= \frac{7200 \times 1}{18} = 400$ g of coal

6. **Location of coal mines :** In India, places where coal is mainly found, are
   (i) Bihar and Jharkhand
   (ii) Madhya Pradesh and Chhattisgarh
   (iii) Orissa and (iv) West Bengal.
7. **Uses of coal:**
   (i) It is used as a fuel.
   (ii) It is used in the manufacture of coke.
   (iii) It is used in producing electricity in thermal plants.
   (iv) It is used in the manufacture of synthetic petrol and synthetic natural gas.
   (v) It is used in the manufacture of industrial fuel gases, (i.e., water gas and producer gas).
8. **Drawbacks**:
   (i) It is a dirty fuel.
   (ii) It is difficult to handle.
   (iii) Coal burning results in the loss of many valuable volatile compounds.
   (iv) It causes pollution by emission of sulphur.

Do You Know

India has about 6% share in the world reserves of coal estimated to be 790 billion tons. It is believed that the available coal reserves may last 250 years more at the present rate of consumption.

- **Petroleum**
  1. **Description***:* Petroleum is a naturally occurring dark coloured oily liquid which is found at various depths below the surface of the earth. The oil derived from oil wells is generally called natural oil or crude oil (it is also called rock oil).
     It is essentially a mixture of hydrocarbons and compounds containing oxygen and nitrogen. The exact composition of crude oil varies from one place to another and from one oil field to another.
  2. **Formation:** According to modern view, the oil has been produced as a result of bacterial decomposition of plants and animals fossils got buried millions of years ago under the earth. The oil in the petroleum field is generally mixed with a gaseous mixture, known as natural gas.
  3. **Procurement (Mining):** Petroleum is obtained by drilling holes in the earth's crust and sinking pipes into it. There are two government agencies which are active in exploration and production of petroleum oil in India. They are :
     (i) Oil and Natural Gas Corporation (ONGC) established in 1956. B
     (ii) Oil India Limited (OIL), established in 1981.
  4. **Locations :** In India, places where petroleum oil is being extracted from oil wells are :
     (i) Assam: Rudra Sagar and Lakwa.
     (ii) Bombay: Bombay High off-shore areas.
     (iii) Godavari and Kaveri : Off shore deltas.
     (iv) Gujarat: Ankleswar and Kalol.
  5. **Uses of Petroleum:** After refining (fractional distillation) many major fractions are obtained. They are given below along with their uses.
     (i) Petroleum gas: Gaseous fuel, LPG, production of carbon black, hydrogen and carbon monoxide.
     (ii) Gasoline: Motor fuel
     (iii) Kerosene: Domestic fuel, illuminant fuel, jet engine fuel.
     (iv) Diesel oil: Fuel for diesel engines.
     (v) Lubricating oil: Lubrication of machines.
     (vi) Paraffin wax: Candles, waterproofing. Vaseline, fabrics. •
     (vii) Petroleum coke (asphalt): Fuel, electrodes, artificial asphalt.
  6. Use of Liquified Petroleum Gas (LPG): LPG is considered as a good fuel. The reasons are :
     (i) It has a high calorific value which is 50 kJ/g.
     (ii) It is very neat and clean domestic fuel.
     (iii) It bums with a smokeless flame and hence does not cause pollution.
     (iv) It does not produce any poisonous gases on combustion.
     (v) It is easy to handle and convenient to store.

- **Natural Gas**

  Natural gas is another source of heat energy. It is a fossil fuel.

1. **Compositions:** It mainly consists of methane (about 97%) and small quantities of ethane and propane.
2. **Compressed Natural Gas (CNG):** When natural gas in liquid form is subjected to high pressure, we get compressed natural gas (CNG).
3. **Use of Natural gas and CNG** :
   (i) Natural gas and compressed natural gas are used as fuel for scooters, buses and trucks.
   (ii) Natural gas is used for cooking food and heating water.
   (iii) Natural gas is used to produce electricity.
   (iv) Natural gas is used for manufacturing fertilizers.

ILLUSTRATION

2. Name place in India where fields of natural gas are found. Why is it called a clean fuel?

Soln. In India, natural gas is found in off shore areas of Mumbai, Krishna-Godavari basin, Jaisalmer, etc.
It is called a clean fuel because
(a) It does not leave residue.
(b) It does not produce smoke.
(c) It does not produce harmful gases,

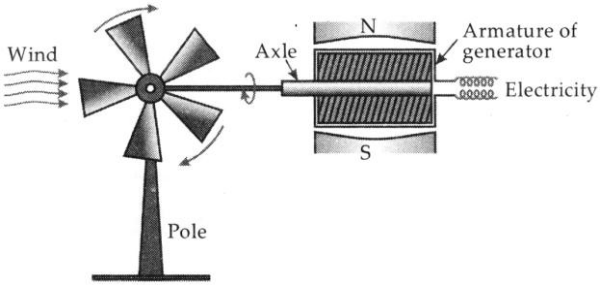
Wind Energy

1. **Definition:** Flow of air is called wind. It possess enormous energy. As the energy is due to motion of air during flow, the energy is kinetic. Wind possesses kinetic energy.
2. **Source of wind energy:** Solar energy heats the entire earth but the heating is not uniform. The heating is more intense near the equator than in the polar region. This makes air in the equator region more hot and light. It rises up and its space is filled with the cooler air from polar region. In this way air flows from colder region at high pressure to hotter region at low pressure. The flow of air from one place to other constitutes wind.
   The smooth flow of air is disturbed continuously by rotation of the earth as well as local conditions. Due to these interacting factor the wind speed may vary from 5 km/h to about 10 km/h (gentle breeze) to very high speed of about 800 km/h of a storm (tornado).
3. **Traditional uses of wind energy:** Even the early man recognized the enormous energy possessed by wind and harnessed it for various purposes like :
   (a) Transportation and to propel the sail boat.
   (b) For grinding grain, pumping out water from wells and flooded areas, mines etc.
   (c) Drying clothes.
   (d) Winnowing
   In search of renewable energy sources, wind power is certainly one of the attractive solution. Now-a-days, wind energy is also used to generate electricity and in flying aeroplanes and gliders.

- **Wind Mill**
  A device used to convert wind energy into the mechanical energy is called wind mill.

1. **Construction:** It consists of a wheel with blades cut into its outer rim. The wheel rotates about anaxle mounted on a pole. The wind energy is used to rotate the wheel abc it its axle.
2. **Uses:** Wind mill is used for operating water pumps, grinders and is also used to produce electricity.

- **Wind Mill for producing electricity (wind generator)**
  Electricity is produced when an armature of a generator rotates between two poles (North and South poles) of a strong magnet. When wind falls on the wheel of a windmill, it rotates. The axle of the armature is connected to the shaft of the wind mill. So the armature of the generator rotates between two poles of a magnet along with the rotation of the wheel of the wind mill. Thus, electric current is produced. This is how, the kinetic energy of the wind is converted into electric energy.



It may be noted that electricity produced by a single wind mill is very small, which cannot be used for commercial purpose. To produce electricity on a region, large number of wind mills are installed. The region where large number of wind mills are erected to produce electricity is called wind energy farm. The small amount of electricity produced by each generator connected to each wind mill is combined to get electricity on a large scale.

Advantages of Wind energy

(a) Wind energy produces no smoke and no harmful gases. So this form of energy is pollution, free or environment-friendly.
(b) Wind energy is free of cost and hence devices operated by wind energy are economical.
(c) This source of energy is a renewable source of energy and is available for all times to come under favourable conditions.

Limitations of Wind energy

(a) We cannot depend upon wind energy as it is available only when air is in motion. The appliances or machines operating with wind energy stop working as soon as wind stops. The minimum speed of wind to operate generator to produce electricity is about 15 km/h. As soon as the speed of the wind becomes less than 15 km/h, the generator stops working.
(b) There are certain regions where wind is not available, so the use of wind energy is limited to certain places where wind is in plenty and blows most of the time.
(c) Wind energy is not sufficient to operate very heavy machines.
(d) Wind energy cannot be used to operate all types of machines.
(e) Wind mills are usually broken during storms and hence lot of money is spent for the maintenance of a wind energy farm.

Wind energy in India

The wind power potential of India is estimated to be 20 billion watt. (20,000 MW). Till the end of last century India has an installed capacity of more than 1025 MW for generating electrical energy from wind energy. This capacity is sure to increase with the commissioning of new power stations. At present, largest wind energy farm is established near Kanyakumari in Tamil Nadu. It can generate 380 MW electricity,

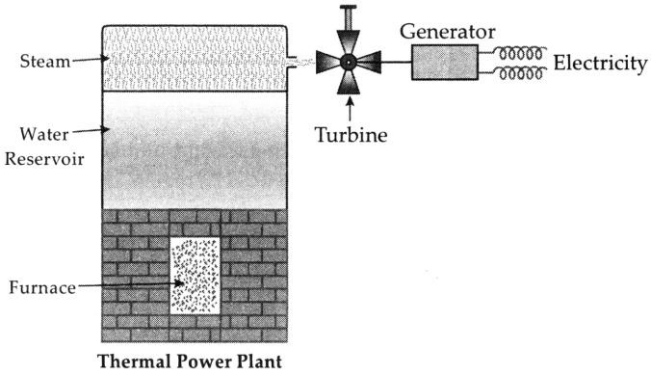
ILLUSTRATION

3. What causes the wind to blow?

Sol. Equatorial regions on the earth receive more solar radiation than other parts of the earth. As such, the air at equatorial regions is hotter and rises upwards into the atmosphere. The cooler air from other regions (especially Polar Regions) starts blowing to the equatorial regions to fill the space vacated by hot air. It is this moving air which is called wind

Thermal Power Plant

A thermal power plant produces electricity by burning the fossil fuels (i.e., coal or oil). A schematic diagram of a thermal power plant is shown in figure.



Thermal Power Plant

- **Working**
  Coal or oil is burnt in a furnace to produce heat energy. This heat energy is used to boil water in a reservoir. The steam produced in the water reservoir is allowed to fall on a turbine under high-pressure. The steam falling on the turbine through an axle rotates the turbine with high speed and produces electricity. In fact, the mechanical energy (kinetic energy of rotation) of the turbineis converted into electrical energy. The electricity, so produced is transmitted to distant places through transmission wires.
  Thermal power plants are usually set up near coal fields or oil fields. This is because the fuel like coal or oil used in a thermal power plant is easily available and there is no problem in transporting the fuel.
- **Disadvantage**
  The burning of coal or oil in a thermal power plant causes environmental pollution and global warming.

Biomass

The wood has been used as a fuel for a long time. If we can ensure that enough trees are planted, a continuous supply of fire-wood can be assured. You must also be familiar with the use of cow-dung cakes as a fuel. Given the large live-stock population in India, this can also-assure us a steady source of fuel. Since these fuels are plant and animal products, the source of these fuels is said to be bio-mass. These fuels, however, do not produce much heat on burning and a lot of smoke is given out when they are burnt. Therefore, technological inputs to improve the efficiency of these fuels are necessary. When wood is burnt in a limited supply of oxygen, water and volatile materials present in it get removed and charcoal is left behind as the residue. Charcoal bums without flames, is comparatively smokeless and has a higher heat generation efficiency Similarly, cow-dung,

various plant materials like the residue after harvesting the crops, vegetable waste and sewage are decomposed in the absence of oxygen to give bio-gas. Since the starting material is mainly cow-dung, it is popularly known as 'gobar-gas'. Bio-gas is produced in a plant as shown in figure below.

Biogas Plant

The arrangement in which Biogas is obtained by the fermentation of biomass is called a biogas plant. The most common types of biogas plants used in India are:

1. Fixed dome type biogas plant
2. Floating gas holder type biogas plant.

Both the biogas plants require animal dung and plant waste as a raw material. Organic domestic and agriculture waste can also be added to it.

1. **Fixed-Dome type Biogas Plant**

Description: It has following sections:

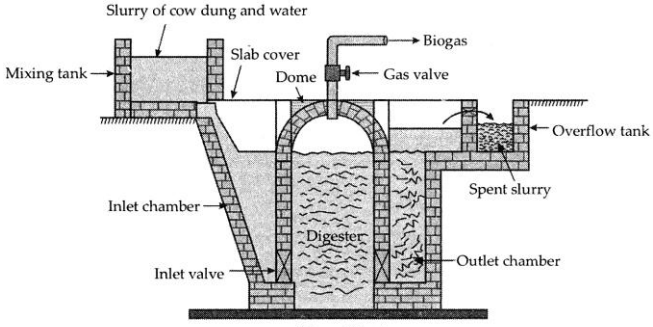
(i) Digester Tank: It is a well like structure made from bricks. Its roof is dome shaped which acts as a fixed strong tank (gas holder) for biogas. A tapped outlet for biogas is provided at the top of the dome.

(ii) Mixing Tank: It is a tank with a sloping floor made up of bricks on one side of the digester. It feeds the slurry to the digester tank. Slurry is a mixture of waste biomass and water mixed in equal proportion.

(iii) Inlet tank: It is made below the ground level under the mixing tank.

(iv) Over flow tank: It is made on other side of the digester as a level lower than mixing tank.

(v) Outlet tank: It is made below the ground level under the overflow tank.



Biogas Plants

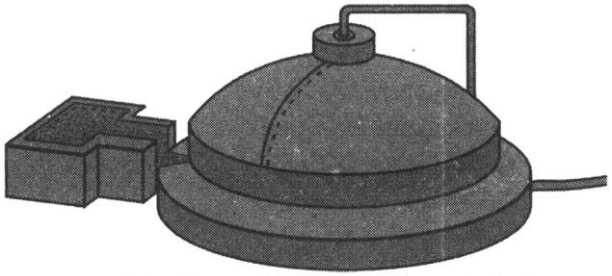
- **Working**

Cow dung and water are mixed in equal proportional in mixing tank to form a slurry. The slurry goes into the inlet tank and the digester and fills about two-third of the digester. The top is left empty for the collection of the biogas. New gas plants take about two months to start functioning. The cow dung undergoes fermentation by anaerobic bacteria to form biogas which gets collected in the dome. As the amount of gas collected in dome increases, it exerts pressure over the slurry and forces the spent slurry in the digester to go out into the outlet tank and from there in overflow tank. The spent slurry is rich in nitrogen and phosphorus compounds and forms a good manure. The biogas collected in the dome is taken out through the tapped-oudet at the top, through a pipe provided with a gas control valve. It is then distributed as desired. Once the gas plant starts functioning, more cattle dung slurry is added to the digester. A continuous supply of biogas can be obtained.

It is cheap and easy to construct fixed dome type biogas plant because the material required is locally available in villages.

2. **Floating Gas Holder Type Biogas Plant**

The floating gas holder type plant is quite similar to the fixed dome type. Only difference is that it has a mobile dome made up of steel which floats over the slurry in the digester. As more and more gas is produced, the steel gas holder rises up, increasing the pressure inside the gas holder. This pushes the spent slurry towards overflow through outlet chamber for removal. The floating gas holder type biogas plant is expensive and has increased cost of maintenance because it has to be painted frequently to prevent it from corrosion and leakage of the gas).


Floating gas holder type Biogas Plant

Advantage of Biogas Plants

(a) We get clean fuel from bio waste.

(b) Animal dung and organic waste is disposed off usefully

(c) Spent slurry is used as manure in the fields.

Uses of Biogas

Biogas is used for cooking, lighting, pumping out underground water for irrigation and to generate electricity.

Advantages of Using Biogas as a Fuel

(a) Burning of biogas does not produce smoke. So it does not cause pollution

(b) Burning of biogas does not leave any ash (no residue is left).
(c) Biogas has higher calorific value than cow dung cakes, wood and charcoal etc.
(d) Use of biogas saves fossil fuels, hence help us in overcoming the energy crisis.
(e) It does not require any storage space in the house.

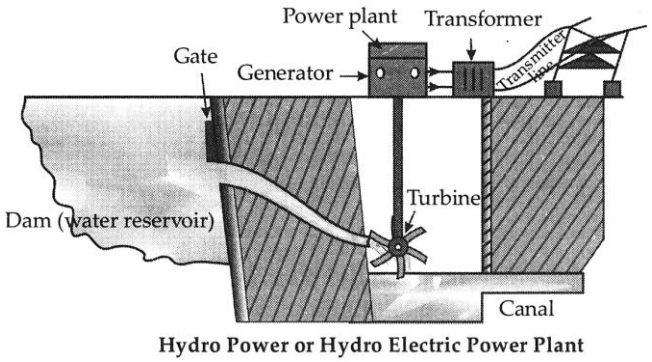
Limitation of using Biogas as a fuel

1. Biogas plants cannot be set up in the cities as quite a large space is required for its set up. Moreover getting dung to run the plant is not viable in cities.
2. Some families may not be able to afford the cost of construction of plant. To overcome the problem of cost and to ensure the availability of dung for the running of plant, it is advisable to set up community biogas plant in which cost of construction as well as the raw material (bio waste) is shared by several families.

Hydro power or Hydro Electric Power Plant

Flowing water is a major source of energy. The electricity produced by the flowing water is known as hydro-electric power. A plant used to produce hydroelectric power is known as hydro-electric power plant.

A dam or water reservoir is made over a river. The energy of stored water in the dam is potential energy. The water in a dam is allowed to fall on the water wheel or turbine. As a result of this, the turbine rotates whose axle is connected with the armature of the generator. The armature of the generator rotates within two poles of a strong magnet. The rotation of the armature of the generator between two poles of a strong magnet gives rise to electric current or electricity. This electricity is transmitted to the sub-stations through a transformer for further distribution to the houses and factories.



Hydro Power or Hydro Electric Power Plant

Principle of Generation of Hydroelectricity

Potential energy of water stored in a dam is converted into kinetic energy of the falling water. The water falls on the turbine, so kinetic energy of the flowing water is converted into the kinetic energy of the armature of the generator connected to the turbine. Then kinetic energy is converted into the electrical energy known as hydro-electricity.

- **Advantages of Hydroelectric power**
  (a) Hydroelectric power is pollution free.
  (b) Hydroelectricity is cheapest source of energy.
  (c) The energy of flowing water is renewable source of energy.
  (d) Lot of water is available in rivers, so the hydroelectric power is available free of cost. Money is spent only to construct dams and power stations.
- **Disadvantages of Hydroelectric Power**
  (a) Hydroelectric power is generated only near the rivers having water throughout the year. This electric power has to be carried to the sub-stations for distribution to the houses and factories situated far off from the sites of hydroelectric power stations. This is done through the transmission wires, so lot of money is to be spent on this process.
  (b) A large area of fertile land is submerged at the site of the dam constructed for tapping energy from the flowing water.
  (c) A large number of people residing near the site of a dam are dislocated. So, a lot of problems are to be faced in rehabilitating this population. That is why, there is a lot of opposition by the people around the site of dam for the construction of dam.
  (d) A large number of plants and wild life in the area of the dam is submerged in water. So, a large variety of flora (plants) and fauna (animals) is destroyed.
  (e) Hydroelectric dams cannot be constructed everywhere. They are constructed mostly in hilly areas.
- **Advantages of constructing Dams over rivers:**
  Dams are helpful to:
  (a) control floods over rivers.
  (b) generate hydro electricity.
  (c) irrigate agricultural land.
  (d) develop water sports for recreation
  (e) develop fishing zones.

The leading users of hydroelectric power include Norway and Brazil (where it account for more than 90% of the domestic electric generation), USA, Canada, China and Russia.

SOLAR ENERGY

(a) Source of solar energy: Nuclear fusion is the source of solar energy (energy from the sun). Sun is a huge spherical ball of fire. Its radius is 7 x 10^8 metre and mass 2 x 10^{30} kg. It is at a distance of 1.5 x 10^{11}metre from the earth. It contains 70% Hydrogen, 28% Helium and 2% Carbon and "other gases. Its inner core has a temperature of 10^7 degree.

At this high temperature, 4 atoms of hydrogen fuse to form one nucleus of helium and release a large amount of energy. This was explained by Hans Bethe in the year 1939.

The reaction is

$$4_1H^1 \rightarrow {}_2He^4 + 2 \text{ positron} + 26.7\,\text{MeV energy}$$

(b) How long will sun last: The sun radiates energy at the rate of 3.9 x 10^{26} W, since 5 billion years. Calculations have shown that the mass of the sun will exhaust in 5 billion years more. Hence solar energy will last till that large span of time. It is for this reason that we call solar energy as renewable (non-depletable). (Earth receives solar energy of about 1.4 kW/m^2).

Solar Cooker

A solar cooker is a solar heating device by which solar energy is directly harnessed. It works on the phenomenon of thermal conversion. It is used for cooking food.

There are two types of solar cookers namely:

(A) Box type solar cooker

(B) Concentrator type solar cooker

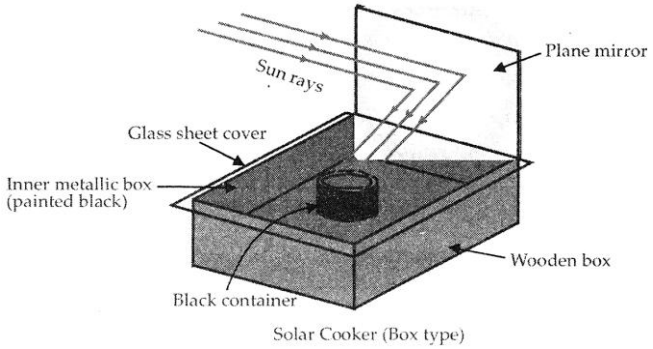
A. Box Type Solar Cooker

1. **Principle:** A box type solar cooker is based on the following facts :

   (i) Glass possesses the property of selective transmission of heat radiation.

   (ii) A black body is a good absorber of heat radiation.

   (iii) A mirror or a polished surface reflects heat radiation according to the laws of reflection.



Solar Cooker (Box type)

2. **Construction:** It consists of an insulated wooden or metallic box. Inside walls of the box are black painted. A plane mirror or reflector is attached to the box and its position is adjustable. It is provided with containers whose outer sides are black painted. A thick glass sheet covers the containers.
3. **Working:** The food to be cooked is taken in the containers which are then placed inside the box. The containers are covered with the glass sheet. The cooker is placed in sunlight and position of the reflector is so adjusted that a strong beam of sunlight is reflected on the top covered with glass sheet. Sunlight passes through transparent glass sheet and is absorbed by the black painted walls of the container and its box. The infrared radiations in the sunlight heat the box and the food inside the container. Inside the box the temperature may go up to 100°C to 140°C in 2 to 3 hours and the food gets cooked.
4. **Demerits:** Box solar cookers are not much popular because (i) it takes long time in cooking the food in them, (ii) they cannot be used for baking (making chapattis) and frying (dal).
5. **Function of thick glass sheet:** Glass sheet has a peculiar property. It allows shorter wavelength infrared (heat) rays at high temperature to pass through it but prevents longer wavelength infrared rays at low temperature.

   The solar energy falling on the outer surface of the cooker glass cover contains short wavelength infrared rays due to high temperature. They all enter the cooker. Inside the cooker (the temperature is less) and longer infrared rays are emitted. They are not allowed to go out. The heat is not wasted and cooker has more efficiency.

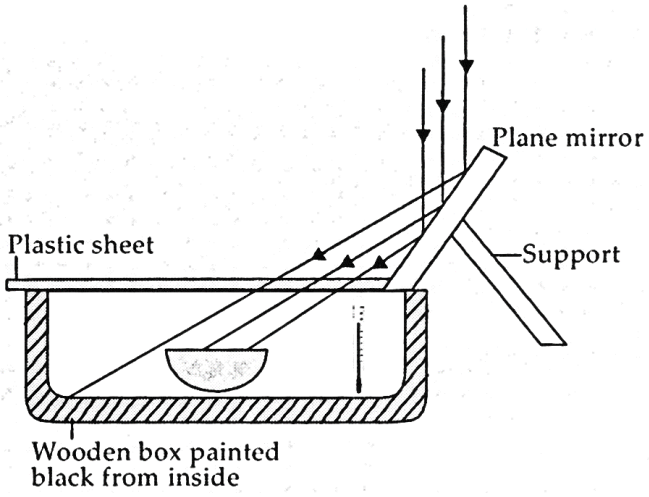
   This function of glass sheet is called greenhouse effect.

ACTIVITY CORNER

To make a box type solar cooker

You are given, a wooden box, plane mirror, thermocole sheet, plastic sheet and thermometer. Take the wooden box, cover the inner wall and bottom surface with thermocole. To increase the efficiency of heat absorbtion you can paint the thermocole layer with back paint. Hing the plane mirror on the top of the solar cooker. Place the plastic sheet on the wooden box. The plane mirror is so adjusted that radiations falling on plane mirror after reflection should reach inside the wooden box. Keep the solar cooker in sunlight and the reflector is adjusted so that strong beam of sun rays may enter the wooden box. You may expect to get a

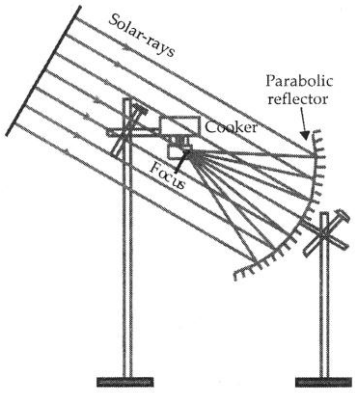
temperature of 100^0C to 120^0C, when kept in sun for 2-3 hours you can measure the temperature using a thermometer. To get temperature up to 140^0C, you can replace plastic sheet by glass sheet.



B. Concentrator Type Solar Cooker

Such solar energy devices which reflect and concentrate solar energy from over a large area into a small area are called solar concentrators.

This type of solar cooker consists of a larger concave reflector or parabolic reflector. The sun rays are focused by this reflector at a point f. The intense beam of sun rays increases the temperature of point F to 200° C. The food to be cooked in a container is placed at point F. The concave reflector must be rotated so that it always face the sun for effective cooking of the food.

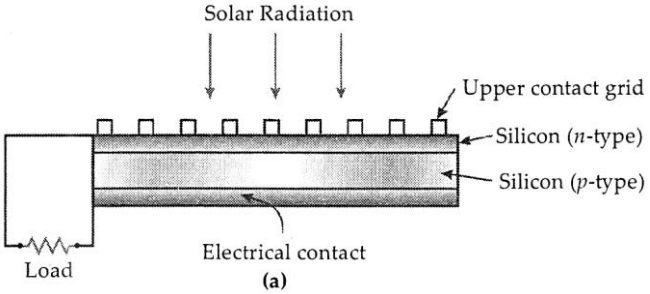


Concentrator type solar cooker

Solar cell

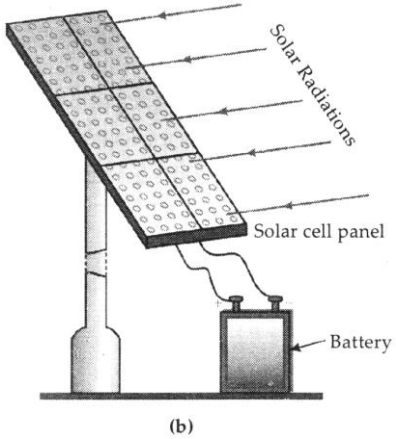
Solar cell is a solar electric device by which solar energy is directly harnessed. It works on the phenomenon of photovoltaic conversion.

1. **Construction:** These days solar cells are usually made from semi-conductor materials likes silicon and gallium (selenium with germanium are also used). Semi-conductors are made impure by adding to them some suitable impurities in suitable amount. These impure semi-conductors have more conductivity. Thin layers (wafers) of the two impure semi-conductors are arranged in such a way that when sun light falls on them, a potential difference is developed between the two regions (junction) of the wafers. This potential difference produces electric current A. 4 cm^2 (2 cm x 2cm) sized cell produces a potential difference of 0.4 volt to 0.5 volt and generates a current of 60 milli ampere (60 mA).
2. **Solar cell panel:** Solar cells usually arranged on large flat sheets constitute a solar cell panel. In a solar cell panel the output of each solar cell gets added and we get much higher power that can be put to various uses.



Solar Cell

The electricity produced by solar panels is stored by using it to charge storage batteries. These charged batteries later on provide direct current (D.C.) for operating appliances.



3. **Applications of solar cell panel:**

(i) These provide electrical power for space-crafts. Its electricity charges batteries inside the craft.

(ii) These provide energy to remote and isolated areas.

(iii) These supply power to domestic electronic appliances like TV., radio sets.

(iv)These provide electricity for street lightening and for operating water pumps.

(iv)These provide electricity to light houses situated in the sea and off-shore drilling platform.

(v))Solar cells are used to run calculator, Watches, pendulum clock and other small instruments.

4. **Advantages (Merits):**

(a) They directly utilize solar energy.

(b) They can work satisfactorily even in diffused radiations.

(c) They need no maintenance.

(d) They do not produce pollution.

5. **Disadvantages (Demerits**):

(a) The energy stored in batteries, provide only direct current (D.C.). For devices which require alternating current (A.C.), D.C. is converted into A.C. Conversion reduces efficiency and increases its cost.

(b) They are very expensive because of use of expensive components like special grade silicon which is limited in nature.

(c) The efficiency of energy conversion is low as compared to other methods of generating electricity.

ILLUSTRATION

3. Why is energy of water flowing in river considered to be an indirect form of solar energy?

Sol. When sunrays fall on water bodies, water evaporates and forms clouds. These clouds produce rainfall and snowfall due to which we get flowing water. Thus, water flowing

Do You Know

Developing countries such as Dominican Republic, Sri Lanka Zimbabwe are leading users of solar cell panels.

ENERGY FROM THE SEA OR OCEAN

1. **Tidal Energy**

(i) Definition: Due to attraction of moon on sea water, water surface rises and falls and waves are formed. These waves are called tidal waves.

(ii) Sources of energy: Rise of ocean water is called high tide and the fall of ocean water is called low tide. These waves (jwar-bhata) in the oceans build up and recede (rise and fall) twice a day. Between the high tides and low tides, there is an enormous movement of water which generates large amount of energy. It occurs in the coastal areas

(iii) Harnessing energy: Tidal Energy can be harnessed by constructing a tidal barrage (or tidal dam). This barrage traps the water risen during the high tide. The trapped water is then allowed to fall down slowly on turbines (water wheels) to start them rotating. The rotating turbines generate electricity.

(iv) Locations chosen: (a) Gujrat-Gulf of Kutch Lamba, (b) West Bengal-Sundervans.

(v) Limitations: The rise and fall of water during tides is not high enough to generate electrical energy on a large scale. There are very few places suitable for building dams. It is for these reason that the tidal energy is not likely to be a major source of energy.

2. **Energy of Ocean Waves**

(i) Definition: Due to blowing of wind on the surface ocean, waves are produced on the water surface. These waves are called ocean waves (sea waves or water waves).

(ii) Source of energy: Ocean (sea) waves move very fast with the blowing wind. This gives kinetic energy to the ocean (sea) waves.

(iii) Harnessing energy: Turbines (water wheels) are so arranged that they are rotated by the moving waves. The rotating turbines generate electricity.

(iv) Commonly utilized devices:

(a) Surface followers: These are a series of floating objects pivoted about a rigid shaft along a coast line. The mechanical linkage between fixed and floating objects produces mechanical power. This mechanical power is converted into electrical energy. Surface followers can trap about 80% of the energy of the waves.

(b) Oscillating water columns (OWC): These are similar to navigational buoys. When waves arrive, they compress air in the vertical pipe of an anchored buoy. This compressed air derives a turbine generator to produce electrical energy.

(c) Focussing devices: These are barriers who channelize water and concentrate a large waves into small area. This focusing action increases the height of waves and water fills an elevated reservoir. When this stored water is released to the sea level, it operates hydroelectric turbines. Electrical energy becomes available.

ILLUSTRATION

4. Mention shortcomings of the energy we get from sea waves

Sol. Short coming of energy from sea wave:

(i) A minimum energy density of 400 MW/km is required to explore energy from sea-waves profitly.

(ii) Initial cost of establishing the plant is hight.

5. List some disadvantages of tidal energy.

Son. Disadvantages of tidal energy:
(i) The range of rise and fall of water during tide is enough to produce electricity on a small scale only.
(ii) Tidal dam cannot be built anywhere on sea-shore.
(iii) It is not a potential source of energy.

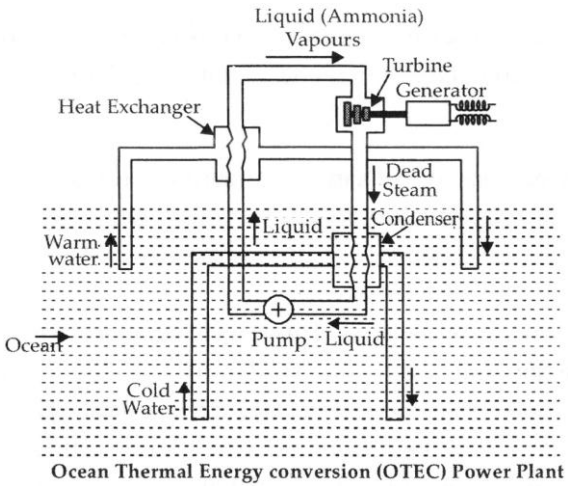
3. Ocean Thermal Energy (OTE)

Heat energy of the sun is absorbed by the surface water of the sea or ocean which increases the temperature of upper layers while the temperature of the deeper layers of water is relatively low. The energy extracted due to difference in the temperature of water at the surface of sea and deep below the sea is called ocean thermal energy.

Harnessing the ocean thermal energy: There is a temperature difference between the water at the surface of the sea and deep below the sea. The difference in temperature at many places is of the order of 20°C. This difference in temperature can be exploited to produce electric energy in ocean thermal energy conversion plant (OTEC).

Ocean thermal energy conversion plant (OTEC)

OTEC is a power plant device used to harness ocean thermal energy and to produce electricity.



Ocean Thermal Energy conversion (OTEC) Power Plant

In one of the methods a low melting point liquid or fluid such as ammonia (volatile liquid) or chlorofluorocarbon (CFC) is used to run the turbine of a generator. The warm surface water is used to boil the liquid like ammonia or CFC in a heat exchanger and vapours thus formed are used to drive the turbine of the generator. In another exchanger cold water from the depth of the ocean is pumped up to condense the vapours of the ammonia again to liquid. This ammonia is reused and the cycle repeats.

Advantages:

1. OTEC system can be operated for 24 hours throughout the year.
2. Unlike the other ocean energy generating system one does not have to wait for tides or waves.

Tides are formed due to attraction of Moon for the ocean water. It is not an indirect form of solar energy.

Geothermal Energy

(a) Definition: Energy harnessed from the heat of the earth, is called geothermal energy (This energy does not come directly or indirectly from solar energy).

(b) Explanation: We know that the deeper regions of the earth's crust are very hot. The heat melts the rocks. The molten rocks called magma formed in deeper hot regions of earth's core get pushed upward and trapped in certain regions (called hot spots) due to geological changes. The magma gets collected at some depth below the earth's surface. These places, called hot spots, become source of geothermal energy.

(c) Procurement: Underground water in contact with the hot spots turns into steam which gets compressed to very high pressure. Thus steam is extracted by linking pipes through holes drilled upto hot spots. The out coming steam rotates the turbine of an electric generator and produces electrical energy.

(d) Locations: In India there are only few places where geothermal energy can be exploited on commercial lines. One such place is located in Madhya Pradesh.

Advantages of Geothermal energy

1. Geothermal energy can be converted continuously into electricity for 24 hours throughout the year.
2. Geothermal energy causes no pollution, so it is environment friendly.
3. The cost of converting geothermal energy into electricity is very less.

Nuclear Energy

A physical reaction which involves changes in the nucleus of an atom is called a nuclear reaction. The energy released during a nuclear reaction is called nuclear energy (because it comes from the nucleus of

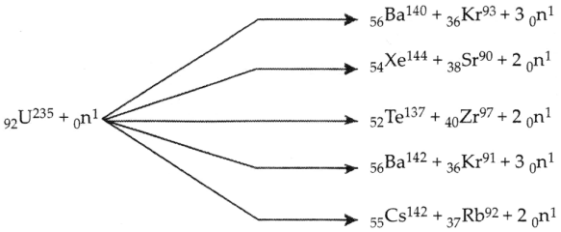
an atom). Nuclear energy can be obtained by two types of nuclear reactions:

(i) Nuclear fission and (ii) Nuclear fusion

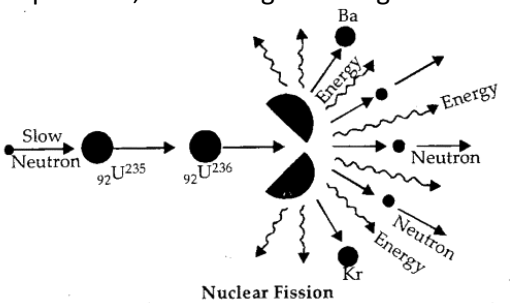
The source of nuclear energy is the mass of nucleus. A small amount of mass of nucleus is destroyed during a nuclear reaction which gets converted into a tremendous amount of energy. The nuclear energy is released mainly in the form of heat (and some light). The nuclear energy is also known as atomic energy because it can be considered to be coming from the atoms. We will now describe the nuclear reactions of fission and fusion in detail, one by one. Let us start with nuclear fission.

- **Nuclear Fission**

  The phenomenon of splitting up of a heavy nucleus, on bombardment with slow speed neutrons, into two fragments of comparable mass, with the release of two or more fast moving neutrons and a large amount of energy is known as nuclear fission. The first nuclear fission to be discovered was that of Uranium-235. This nucleus as well as those of uranium-233 and plutonium-239 undergo fission when struck by slow moving neutrons. There are other heavy nuclei that can be induced to undergo fission. However these three are the only ones of practical importance. Few different ways in which the Uranium-235 nucleus splits are shown below:



  Over 200 different isotopes of 35 different elements have been found among the fission products of Uranium-235. Most of them are radioactive. The schematic representation of the fission of Uranium-235, showing one of its many fission patterns, has been given in figure.



Nuclear Fission

  On the average, 2, 3 neutrons are produced by every fission of U-235. If one fission produces 2 neutrons, these two neutrons can cause two fission on hitting another U-235 nucleus. The 4 neutrons thereby released can produce four fission and so on.

In this way, the secondary neutrons (formed during fission) further cause fission and thus set up chain reaction releasing huge amount of energy.

The tremendous amount of energy released during fission is due to mass defect. The sum of the mass of fragments produced and neutrons released during fission is less than the sum of target U-235 nucleus and bombarding neutrons. For example, the loss in mass during fission can be derived as:

In amu $\underset{\underbrace{235.118\ \ 1.009}_{236.127}}{{}_{92}U^{235} + {}_0n^1} \quad \underset{\underbrace{143.881\ \ 89.947\ \ 2.018}_{235.846}}{{}_{56}Ba^{140} + {}_{36}Kr^{93} + 3_0n^1}$

Thus, mass defect,

$\Delta m = 236.127 - 235.846 = 0.281\,\text{amu}$

$\because 1\,\text{amu} = 931.478\,\text{MeV}$

$\therefore \Delta E = \Delta m \times 931.4780$

[from Einstein equation, $\Delta E = \Delta mc^2$

$= 931.478 \times 0.281 = 261.75\,\text{MeV}$

Thus, for the fission of each nucleus of Uranium-235, about 261.75 MeV energy is released which corresponds to about 8 x 10^7 kJ per g of uranium. It is also evident that about 0.1% (0.281 amu out of 236 amu) of the total mass undergoes decay and produces energy. Note that most of the energy is released out in the form of kinetic energy.

The pressure and temperature increases tremendously during fission.

For a fission chain reaction to occur, the fissionable material must have a minimum mass. Otherwise, neutrons will escape from the sample before they have the opportunity to strike another nucleus and cause additional fission. The chain stops if enough neutrons are lost. The amount of material is then said to be a subcritical mass. The amount of fissionable material large enough to maintain the chain reaction with a constant rate of fission is called the critical mass. When a critical mass of material is present, only one neutron from each fission is subsequently effective in producing another fission. The critical mass of uranium-235 is about 1 kg. The chain reaction multiplies the number of fission reactions showing very few secondary neutrons to escape if more than a critical mass of fissionable material is present. A mass in excess to critical mass is referred as supercritical mass and this leads to a violent nuclear explosion.

Nuclear fission is an uncontrolled reaction in atom bomb whereas in nuclear reactors, it is controlled by using control rods of boron, steel or cadmium

which capture some of the neutrons so that chain reaction does not become violent, slowing down the speed of neutrons by moderators e.g., D^2O, graphite so that neutrons can be captured more readily by the fuel. A circulating coolant (water, molten Na) is employed to remove the heat from the reactor to outside where it is used for power production. The coolant liquid can also serve as the neutron moderator.

U^{238} does not show fission by slow speed neutrons and that is why refining of Uranium is necessary before its use as nuclear fuel in nuclear reactors. Natural uranium consists of 99.3% U^{238} + 0.7% U^{238}. Elements upto ygTa have been found to undergo fission. $_{94}Pu$ was used in the first atom bomb explosion at Hiroshima in Japan.

- **Nuclear Power Plant**

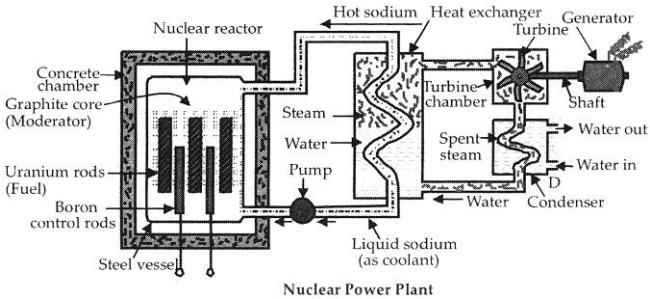
If only one of the neutrons produced in each fission is able to cause further fission, then the process is slow and the energy is released steadily. Such a chain reaction is called as controlled chain reaction. The energy released in this process can be utilized for peaceful purposes. This is actually what happens in nuclear reactors.

Nuclear fission produces the energy generated by nuclear power plants using nuclear reactors. The energy liberated in a controlled manner is used to produce steam which can run turbines and produce electricity. In nuclear reactors, the nuclear fission is controlled by controlling the number of neutrons released during the fission. Controlling of neutrons is based upon the fact that cadmium and boron can absorb neutrons to form the corresponding isotopes which are not radioactive.

$$_{43}Cd^{113} +_0 n^1 \rightarrow_{43} Cd^{114} + y - ray$$

$$_5B^{10} +_0 n^1 \rightarrow_5 B^{11} + y - ray$$

The design of a nuclear power plant is basically the same as that of a power plant that burns fossil fuel except that the burners are replaced by a reactor core. In both instances, steam is used to drive a turbine connected to an electrical generator.



Nuclear Power Plant

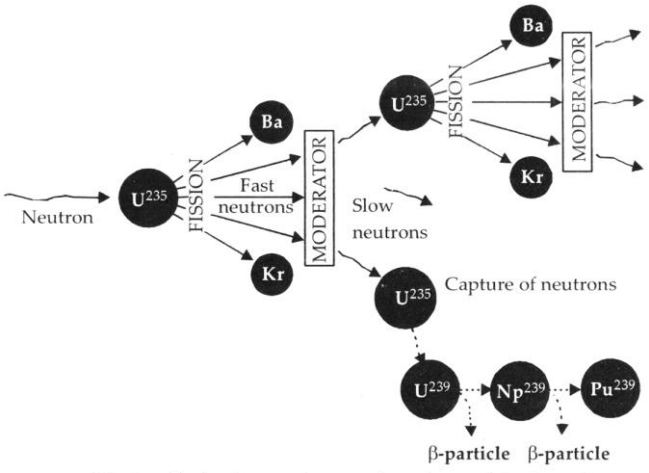
(a) Fuel rods: The fuel of the nuclear reactor is a fissionable substance such as U235, Typically, uranium is enriched to about 3% U235 and then used in the form of rods or pallets. These enriched uranium rods are encased in zirconium or stainless steel vessel.

(b) Control rods: Rods made up of material such as cadmium or boron suspended between the fuel rods control the fission process by absorbing neutrons. These control rods regulate the flow of neutrons by lowering or rising up to keep the reaction chain self-sustaining, while preventing the reactor core from overheating.

(c) Moderator: The reaction is started up by a neutron emitting source. The reactor core also contains a moderator, which acts to slow down the speed of neutrons so that they can be captured more readily by the fuel and the fission process can take place more efficiently. Heavy water (D_2O) and graphite acts as good moderators. The moderator is arranged so that it surrounds the fuel rod to give more efficient action.

(d) Coolant: A coolant liquid (molten Na or heavy water) circulates through the reactor core to carry off the heat generated by the nuclear fission. The liquid enters the base of the reactor core and come out at the top. The heat carried by the circulating liquid coming out from top is used for producing steam. As a result the liquid cools down and is pumped back to the base of the reactor. The cooling liquid also serves as the neutrons moderator.

(e) Shield: The entire reactor core is enclosed in a heavy steel or concrete dome (the shield) to prevent the loss of heat and to protect the persons operating the reactor from radiation.



Nuclear fission in a nuclear reactor using enriched uranium

The nuclear power plants convert huge amount of energy produced during controlled fission into electrical energy. Four nuclear power plants have

been set up in India at Tarapur, Kota, Narora Kalpakkam Kaiga and Kakrapar. The reactors in which energy is produced by the fission of U235 by slow speed neutrons are called thermal reactors.

Nuclear Bomb (or Atom Bomb)

The highly destructive nuclear bomb (or atom bomb) is based on the nuclear fission reactions of uranium-235. In the nuclear bomb, the fission reaction of uranium-235 (or plutonium-239) is deliberately allowed to go out of control so as to produce an enormous amount of energy in a very short time. This energy causes destruction all around. The atom bombs based on the fission of Uranium-235 and Plutonium-239 were dropped on the Japanese cities of Hiroshima and Nagasaki, respectively in 1945 during the Second world war. Both these atom bombs caused a reat loss of human life and property. About 1.54 lakh people were killed in these two atom bomb attacks.

ILLUSTRATION

6. In one fission of uranium, $3\times10^{-11}J$ of energy is made available. Calculate the total number of fissions necessary per second to generate power of 15 kw.

Sol. Energy released per fission $3\times10^{-11}J$

Total energy required per s =15kw

=15kw=15000 W=15000 J/S.

Number of fissions per s = $\frac{totlenergy/s}{energy/fission}$

$=\frac{15000}{3\times10^{11}}=5\times10^{14}$

Nuclear Fusion

The process of combination of two light nuclei to form a heavy nucleus is known as nuclear fusion. Obviously, the process of fusion is just the reverse of fission. An important feature of fusion is that there is a release of huge amount of energy in the process. This can be easily understood. When two light nuclei combine to form a heavy nucleus, there occurs a small mass defect. In other words, the mass of the heavy nucleus turns out to be less than the sum of the masses of two light nuclei. This small mass defect results in the release of a huge amount of energy according to Einstein mass-energy relation

$$\Delta E=\Delta m\times c^2$$

For example, by the fusion of two nuclei of heavy hydrogen or deuterium ($_1H^2$), the following reaction is possible:

$$_1H^2+_1H^2\rightarrow_1H^3+_1H^1+4.0 \text{ Mev}$$

The nucleus of tritium ($_1H^3$) so formed can again fuse with a deuterium nucleus:

$$_1H^3+_1H^2\rightarrow_2He^4+_0n^1+17.6 \text{ Mev}$$

The net result of these two reactions is that three deuterium nuclei fuse together to form a helium nucleus and release 21.6 MeV energy which is obtained in the form of kinetic energy of proton ($_1H^1$) and neutron $_On^1$),

Alternatively, following reactions are also possible for the fusion of three deuterium nuclei:

$$_1H^2+_1H^2\rightarrow_2He^3+_0n^1+3.3 \text{ Mev}$$

$$_2He^3+_1H^2\rightarrow_2He^4+_1H^1+18.3 \text{ MeV}$$

The energy output in the process of nuclear fusion (21.6 MeV) is quite less than the energy liberated in the fission of a U^{235} nucleus (200 MeV). But this does not imply that fusion is a weaker source of energy than fission. The number of hydrogen nuclei in 1 gram of heavy hydrogen is much more than the number of U^{235} nuclei in 1 gram uranium. Therefore, the energy by the fusion of a certain mass of heavy hydrogen is much more than the energy released by the fission of equal mass of uranium. It may alternatively be explained as:

	Fusion reaction	Mass defect	Energy released
	$_1H^2+{}_1H^2\longrightarrow{}_1H^3+{}_1H^1$	4.3×10^{-3} amu	4.0 MeV
	$_1H^3+{}_1H^2\longrightarrow{}_2He^4+{}_0n^1$	18.9×10^{-3} amu	17.6 MeV
Net	$3\,{}_1H^2\longrightarrow{}_2He^4+{}_1H^1+{}_0n^1$	23.3×10^{-3} amu	21.6 MeV

Thus, a mass defect of 23.2 x 10^{-3} amu is noticed out of 6 amu or about 0.386% mass decay is responsible for release of energy (In nuclear fission it was 0.1%). Huge amount of energy is required to overpower the Coulombic forces of repulsion between two nuclei which is obtained by triggering nuclear fission. The temperature corresponding to nuclear fusion is about 1.2 x 10^7 K. The requisite condition for fusion reaction exists in stars and in the sun. Though the sun's surface temperature is only about 6000 K, its internal temperature is as high as 1.5 x 10^7 K. Under these conditions, H nuclei undergoes fusion to form Helium nuclei and in the process a continuous emission of solar energy occurs. Therefore, fusion is also referred to as thermonuclear reaction.

It is an uncontrolled reaction and the principle is used in the formation of Hydrogen bomb.

Hydrogen Bomb (A Fusion Bomb)

1. Principle: It works on principle of nuclear fusion (which is an uncontrolled nuclear reaction).

2. **Construction:** It consists of an arrangement for nuclear fission at the centre of a mixture of deuterium ($_1H^2$) and lithium ($_3Li^6$).
3. **Working:** The nuclear fission provides heat and neutrons.
   Fission (in the centre) $\rightarrow$ Heat + Neutrons
   Neutrons are used in converting lithium into tritium ($_3H^1$) and heat is liberated.
   $$\underset{\text{Neutron}}{_0n^1} + {}_3Li^6 \rightarrow \underset{\text{Tritium}}{_1H^3} + Heat\ energy$$
   Heat liberated starts fusion between $_1H^2$ and $_1H^3$ and liberates large amount of energy
   $$\underset{\text{Deuterium}}{_1H^2} + {}_1H^3 \rightarrow {}_2He^4 + {}_0n^1 + Energy$$
   $$_1H^3 + {}_1H^3 \rightarrow {}_2He^4 + 2{}_0n^1 + Energy$$
   $$_1H^2 + {}_1H^2 \rightarrow {}_2He^4 + Energy$$
   Tritium has to be produced within the hydrogen bomb because it is not stable.
4. **Enormousity of the energy produced:** In formation of a single Helium nucleus four nudeons (2_1H^2) take part and 26.7 MeV of energy is produced.
   Hence, energy released per nucleon = $\frac{26.7}{4} = 6.675MeV$
   It is about 8 times more than in fission. This fact makes hydrogen bomb 8 times more dangerous than atom bomb which is a fission bomb.

Source of Energy of the sun-nuclear fusion

Hans Bethe in 1939 suggested that the source of energy of the Sun and other stars is thermo- nuclear or nuclear fusion reactions.

ILLUSTRATION

7. 48 KJ of energy is produced per minute in a nuclear reactor. Calculate the number of fission which would be taking place in a reactor per second, if the energy released per fission is $3.2\times10^{-11}J$

Sol. In 60 second, the energy produced
=48 KJ
In 1 second, the energy produced

Advantages of Nuclear Energy

The advantages of nuclear energy are that:
(a) it produces a large amount of useful energy from a very small amount of a nuclear fuel (like uranium-235).
(b) once the nuclear fuel (like uranium-235) is loaded into the reactor, the nuclear power plant can go on producing electricity for two to three years at a stretch. There is no need for putting in nuclear fuel again and again.
(c) it does not produce gases like carbon dioxide which contributes to greenhouse effect or sulphur dioxide which causes acid rain.

Disadvantages of Nuclear Energy

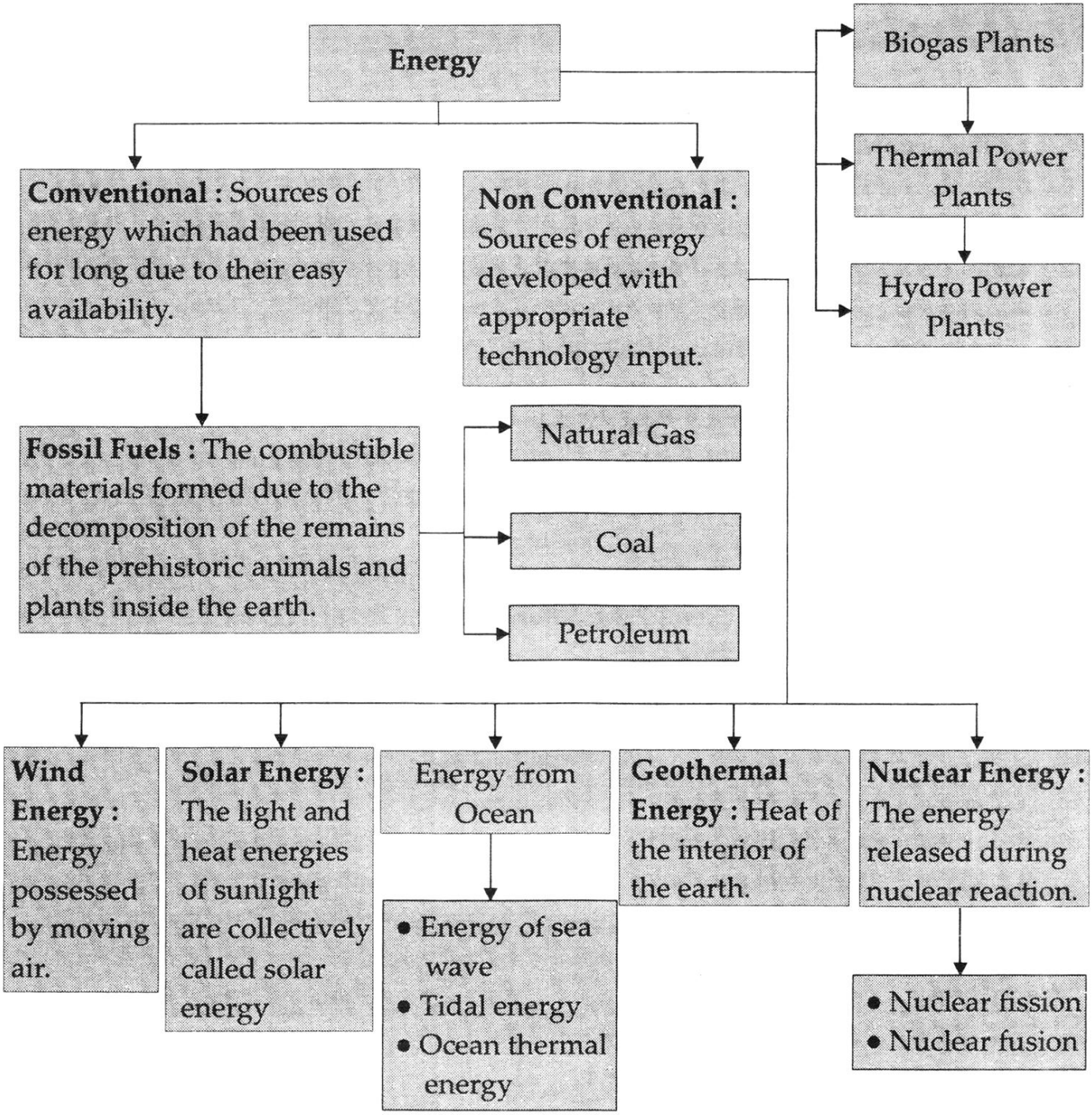
The disadvantage of nuclear energy are that:
(a) the waste products of nuclear reactions (produced at nuclear power plants) are radioactive which keep on emitting harmful nuclear radiations for thousands of years. So, it is very difficult to store or dispose of nuclear wastes safely. Improper nuclear waste storage or disposal can pollute the environment.
(b) there is the risk of accidents in nuclear reactors (especially the old nuclear reactors). Such accidents lead to the leakage of radioactive materials which can cause serious damage to the plants, animals (including human beings) and the environment.
(c) the high cost of installation of nuclear power plants and the limited availability of uranium fuel make the large scale use of nuclear energy prohibitive.

ESSENTIAL POINTS For COMPETITIVE EXAMS

- The various sources of energy are the sun, the wind, water, fossil fuels etc.
- A good source of energy is one which supplies large amount of useful energy, easily available, economical and cause minimum environmental pollution.
- Electricity produced by flowing water is known as hydro-electric power.
- Biomass is a material which contains carbon and other combustible material.
- Plants, wood, animals and plants waste are the examples of biomass.
- Gobar gas or bio-gas is the example of a bio-mass energy source.
- Main constituent of a biogas or gobar gas is methane gas.
- Biogas plant is an arrangement of producing biogas from animal dung, human excreta, industrial and domestic wastes.
- Biogas plant is of two types : (a) Fixed-dome type, (b) Floating gas holder type
- Constant and rapid use of conventional sources of energy would ultimately exhaust these sources and hence a need for tapping energy from alternate or non-conventional sources of energy is seriously felt.

- Solar constant is defined as the energy received from the sun in one second by a unit square metre area of the outer edge of earth's atmosphere exposed perpendicular to the radiation of the sun at an average distance between the sun and the earth.
- Value of solar constant =1.4 kW/m^2
- Water due to its high specific heat capacity (4200 $J\ kg^{-10}C^{-1}$) is a store house of heat energy,
- Energy from sea or ocean water is available in the form of (i) Energy of sea waves (ii) Tidal energy and (iii) Ocean thermal energy (OTE).
- The heat energy stored in the hot spots of earth's crust is called geo-thermal energy.
- The energy obtained from the conversion of nuclear mass is known as nuclear energy.
- Nuclear energy is obtained by two processes known as nuclear fission and nuclear fusion,
- Nuclear energy is expressed in electron-volt (eV)
  $1\ eV = 1.6 \times 10^{-19}\ J$
  $1\ MeV = 10^6\ eV = 1.6 \times 10^{-13}\ J$
- Nuclear fission is the process of splitting a heavy nucleus (say Uranium) into two comparatively higher nuclei along with the release of large amount of energy when bombarded with thermal neutron.
- Energy released per fission of $_{92}U^{235}$ is about 200 MeV.
- Nuclear reactor is a device used to carry out controlled chain reaction.
- Nuclear fusion is the process of fusing or combining together two small nuclei to form a comparatively big nucleus with the release of large energy.
- Nuclear fusion reactions occur at very high temperature (10^7 K).
- Source of energy are classified in to two categories (i) conventional or non-renewable sources of energy and (ii) Non-conventional or renewable sources of energy.

CONCEPT MAP



SOLVED EXAMPLES

1. A student has set up a solar cooker in a box by using a black painted aluminium sheet, a black cooking vessel, some glass wool, a glass sheet and a mirror plate. What is the role of each item used in the solar cooker?

Sol. Black painted aluminium sheet absorbs heat radiation.
Black cooking vessel also absorbs heat radiation to cook food.
Glass wool prevents the loss of heat.
Mirror plate reflects the sunlight to fall on the glass sheet.

2. A student constructed a box type solar cooker. He found that it did not work efficiently. What could this be due to? Give any four possible mistakes in the construction and operation of the solar cooker. What maximum temperature can ordinarily be reached inside a solar cooker?

Sol. He might be committing the following mistakes:
(i) He might have blackened the interior of the solar cooker.
(ii) He might be using a plastic cover instead of a glass cover.
(iii) He might have not made it insulated.

(iv) He might have not used black containers. Maximum temperature attained in a solar cooker is about 140°C.

3. Solar energy is falling on the surface of a concentrator type solar heater at the rate of 0.4 kW/m^2. If the surface area of the heater is 5 m2 and it reflects only 80% of the total solar energy falling on it to its focus, calculate the energy concentrated on the focus of the heater is 2 hours.

Sol. Rate at which solar energy is falling on the surface of heater = 0.4 kW/m^2

= 0.4 kJ / sm^2 ($\because$ 1W = 1 J/s)

It means, energy falling on 1 m^2 area of the surface of heater in 1 second = 0.4 kJ

As, the surface area of heater = 5 m^2

$\therefore$ Energy falling on 5 m^2 area of the surface of heater in 1 second = 0.4 x 5 kJ = 2 kJ.

Since, the surface of heater is reflecting only 80% of he total solar energy falling on the surface of the heater to be focussed at the focus of the heater, the solar energy concentrating on the focus of the heater in 1 second = 80% of 2 kJ

$$= \frac{80}{100} KJ = 1.6KJ$$

4. (a) Name the device used to convert (i) solar energy into heat and (ii) Solar energy into electricity, (b) Explain the working of a wind mill.

Sol. (a) (i) Solar cooker (ii) Solar cell.

(b) When wind blows with a minimum speed of 15 km/h, the kinetic energy of the wind is used to rotate the blades of wind mill. The rotational energy of the blades is used to rotate the armature of the generator to produce electricity.

5. Out of two solar cookers, one was covered by a plane glass slab and the other was left open. Which of the two solar cookers will be more efficient and why?

Sol. A solar cooker covered by a plane slab will be more efficient.

This is because glass slab does not allow the heat radiation to escape from the solar cooker arid hence the temperature of the solar cooker covered with glass slab increases more than the temperature of the solar cooker which is left open.

6. In which forms the solar energy stored in the oceans? Mention any two forms that could be harnessed to obtain energy in usable form.

Sol. Solar energy is stored in many forms in ocean, namely,

Sea-waves energy. Ocean thermal energy, tidal energy, energy from salinity gradient.

(i) Tidal energy - The rise of ocean water due to the attraction of moon is called a tide. The enormous movement of water between high and low tides carry large amount of energy which can be used to run the turbine and electricity can be produced.

(ii) Energy from salinity gradient. The concentration of salts in water of different seas is different. This is used to trap energy in useful form.

7. Electricity generated at hydroelectric power stations is considered to be another form of solar energy. Explain.

Sol. The energy of water (or hydro-energy) is in fact an indirect source of solar energy because it is the solar energy which is responsible for water cycle. The heat of solar energy evaporates water from ocean and the surface of the earth. The water vapours rise high in the atmosphere, get cooled and fall back to the earth in the form of rain and snow. The rain water and the water formed by melting of snow then flows rapidly in the rivers and provides us with hydro energy.

8. (a) Name the device used to convert (i) solar energy into heat, and (ii) solar energy into electricity.

(b) Explain the principle of working of a wind mill.

Sol. (a) (i) Solar energy into heat-solar cooker.

(ii) Solar energy into electricity-solar cell.

(b) Principle of working of windmill: When the blowing air strikes across the special design blades of a windmill, blade starts rotating. The rotation is due to the pressure difference between the different regions thereby exert a force on the blades. The speed of rotation, however, may increase or decrease depending upon the wind velocity at that places.

9. Explain why:

(i) It is difficult to burn a piece of wood fresh from a tree.

(ii) Pouring dry sand over the fire extinguishes it.

(iii) It is difficult to use hydrogen as a source of energy.

(iv) Charcoal is considered a better fuel than wood.

Sol. (i) It is because a piece of fresh wood is not dry and therefore it is to be heated at high temperature before it catches fire, that is why it is difficult to burn.

(ii) It cuts off the supply of air (oxygen) which is required for combustion to take place.
(iii) Hydrogen is highly combustible and burns with an explosion, therefore, it is difficult to store and transport.
(iv) Charcoal, has higher calorific value than wood and produces less smoke than wood.

10. What is nuclear fusion reaction? Why are such reaction not possible in the school laboratory? State the amount of energy released by one gram of hydrogen in the sun.

Sol. Nuclear fusion reaction is the reaction in which lighter nuclei combine to form heavier nucleus, with the release of large amount of energy. These reactions are not possible in school laboratory, since the energy released is quite high and difficult to handle.
One gram of hydrogen releases 62,000,000,000 or 62 x 10^9 energy.

11. Explain what happens when two protons moving at high speed collide with each other.

Sol. When two protons moving at high speed collide, one of the proton gets itself converted into a neutron with the release of a positron and neutrino and large amount of energy.

$$p + p \rightarrow p + n + e^+ + v + \text{energy}$$

12. Give some difference between conventional sources of energy and non-conventional sources of energy?

Sol.

Conventional sources of Energy	Non-conventional sources of Energy
1. Energy sources which are being used traditionally for any years and going to deplete over a period of time are called conventional sources of energy.	**1.** Energy sources which do not deplete and are scarcely used by the population are called non-conventional sources of energy.
2. Usually they are nonrenewable sources of energy.	**2.** Usually they are renewable sources of energy.
3. Examples of conventional sources' of energy are: (a) Fossil fuels (b) Thermal power plant (c) Hydro power plant	**3.** Examples of non-conventional sources of energy are : (a) Solar energy (b) Energy from the sea (c) Geothermal energy (d) Nuclear energy
4. Most of the conventional sources of energy cause environmental pollution.	**4.** Most of the non-conventional sources of energy do not cause environmental pollution

NCERT SECTION

1. What is a good source of energy?

Ans. A good source of energy is one which:
(i) performs a large amount of work per unit volume or mass,
(ii) is easily accessible,
(iii) is easy to store and transport,
(iv) is economical.

2. What is a good fuel?

Ans. A good fuel is one which:
(i) has high calorific value, i.e., produces large amount of heat on burning completely in air or oxygen,
(ii) produces less smoke on burning,
(iii) has low cost and is easily available,
(iv) has an ignition temperature that is well above the normal temperature.

3. If you could use any source of energy for heating your food, which one would you use and why?

Ans. For heating food, I shall prefer to use solar energy (through the use of solar cooker/reflector) because it is virtually free and nonpolluting.

4. What are the disadvantages of fossil fuels?

Ans. Various disadvantages of fossil fuels are:
(a) Fossil fuels cause air pollution.
(b) Fossil fuels produce gases like, CO_2, SO_2, SO_3, NO_2. The gases such as SO_2, SO_3, and NO_2 cause acid rain.
(c) Excess of CO_2, contributes to the global warming due to its greenhouse effect.

5. Why are we looking at alternate sources of energy?

Ans. Fossil fuels were formed due to extraordinary conditions that prevailed on the Earth many million years ago. No new reservoirs of these fuels are being formed due to the absence of those conditions. As such fossil fuels are non-renewable sources of energy. In case we continue to use these sources at the present rate, we would soon be deprived of these sources. It is due to this reason that we should conserve these sources and look for alternate sources of energy.

6. How has the traditional use of wind and water energy been modified for our convenience?

Ans. Traditional use of wind and water energy have been modified in the following ways:
(a) Wind energy: Through windmill-Windmill can be used for running water pump, grinding grains and generating electricity.

(b) Water energy: Through the use of hydro energy, by constructing dams and setting up hydroelectric power stations.

7. What kind of mirror concave, convex or plane-would be best suited for use in a solar cooker? Why?

Ans. A concave mirror is best suited for use m a solar cooker. This is due to the reason that a concave mirror reflects and concentrates solar energy from over a large area into a small area. Such a mirror is called a solar concentrator.

8. What are the limitations of energy that can be obtained from the oceans?

Ans. The energy obtained from the oceans is:
(i) tidal energy for which very few suitable sites are available for construction of dams and the power generation is intermittent and not very large.
(ii) wave energy where power output is variable and the presently available technologies are very expensive.
(iii) ocean thermal energy where the conversion efficiency is low (3% - 4%) and a lot of capital investment is required.

9. What is geothermal energy?

Ans. The heat of the interior of the earth is called geothermal energy.

10. What are the advantages of nuclear energy?

Ans. Some advantages of nuclear energy are:
(a) On equal mass basis, nuclear energy systems produce much more energy than fossil fuels. One gram of uranium-235 produces $8.25\times10^{7}\,kJ$ of energy whereas one gram of coal produces only 30 kJ.
(b) If maintained and operated properly, nuclear energy systems produce almost no air pollution.
(c) Nuclear energy systems consume very little fuel. Once loaded/ a nuclear reactor operates for years together.

11. Can any source of energy be pollution-free? Why or why not?

Ans. No source of energy can be called pollution-free, because, the use of any source of energy disturbs the environment in one way or the other. A source of energy like a solar cell is pollution free in actual operation but the assembly of the device might have caused some damage to the environment. So, in absolute sense, no source of energy can be called pollution free.

12. Hydrogen has been used as a rocket fuel. Would you consider it a cleaner fuel than CNG? Why or why not?

Ans. Hydrogen is a cleaner fuel than CNG. This is due to the reason that it produces water on burning whereas CNG on burning produces CO_2, though much less than that produced when coal or oil is burnt. The increase in concentration of CO_2 in the atmosphere increases the temperature of atmosphere.

13. Name two energy sources that you consider to be renewable. Give reasons for your choices.

Ans. (i) Water energy (hydro-energy); (ii) biomass energy.
Water on Earth can be used again and again to generate hydro-energy as obvious from water cycle in nature. Solar energy also appears in the form of energy of water flowing in the rivers.
This is obvious from the water cycle in nature which is as follows.
(a) Solar energy changes into potential energy of water vapour rising in the atmosphere during evaporation of water from rivers, seas, oceans and other water masses. The water vapour form clouds and also cover mountains with snow.
(b) When the clouds bring rain and the snow on the mountains melts their potential energy changes into the kinetic energy of water flowing in the river and streams. Biomass can be managed by replacing the trees that have been cut down for fire-wood. By doing so, we can get a constant supply of energy at a particular rate.

14. Give the names of two energy sources that you would consider to be exhaustible. Give reasons for your choices.

Ans. (i) Coal (ii) Petroleum and Natural gas.
Both these sources are present only in limited amounts and will be exhausted soon if we continue to use them at the present rate. These sources were formed over millions of years under special conditions.

15. A solar water heater cannot be used to get hot water on
(a) a sunny day.
(b) a cloudy day.
(c) a hot day.
(d) a windy day.

Ans. The correct answer is (b). Because on a cloudy day, heat radiation coming from the sun do not reach the solar water heater.

16. Which of the following is not an example of a biomass energy source?
(a) wood (b) gobar-gas

(c) nuclear energy (d) coal

Ans. The correct answer is (c). Nuclear energy uses uranium which is mineral.

17. Most of the sources of energy we use represent stored solar energy. Which of the following is not ultimately derived from the sun's energy?
(a) geothermal energy (b) wind energy
(c) nuclear energy (d) biomass

Ans. The correct answers are (a) and (c).
Geothermal energy and nuclear energy are not, in any way, derived from the sun's energy.

18. Compare and contrast fossil fuels and the Sun as sources of energy.

Ans. (i) The reserves of fossil fuels are limited, i.e., exhaustible whereas solar energy in available in abundance and that too without cost), i.e., is inexhaustible.
(ii) Fossil fuels cause pollution on burning whereas solar energy is pollution free.
(iii) Fossil fuels can provide energy at any required time whereas solar energy becomes unavailable when the sky is covered with clouds.

19. Compare and contrast bio-mass and hydro-electricity as sources of energy.

Ans. (i) Bio-mass is a renewable source of energy only if we plant trees in a planned manner which is not the case with hydroelectricity.
(ii) The energy from bio-mass can be obtained by using a chullah or a gobar gas plant whereas hydroelectricity requires construction of dams on rivers.
(iii) Bio-mass provides pollution-free energy only when converted into biogas whereas hydroelectricity is totally pollution-free.

20. What are the limitations of extracting energy from
(a) wind (b) waves (c) tides

Ans. (a) Limitations of extracting energy from the wind:
Wind flowing with a sufficient speed is not available everywhere and all the time. Thus wind is not a dependable source of energy. The kinetic energy of wind (wind energy) can be used only at the site of windmill.
(b) Limitations of extracting energy from ocean waves:
Wave energy would be commercially viable only at places where the waves are strong.
The energy produced from waves has to be transmitted through long distances at the possible of use.
(c) Limitations of extracting energy from tides:
There are very few sites suitable for harnessing tidal energy.
The rise and fall of water during tides is not very large. So, large scale generation of electricity is not possible.

21. On what basis would you classify energy sources as
(a) renewable and nonrenewable?
(b) exhaustible and inexhaustible?
Are the options given in (a) and (b) the same?

Ans. (a) Energy sources can be classified as renewable and nonrenewable on the following basis:
(i) Quantity available in nature
(ii) Mode of replenishment
(iii) Rate of consumption
(b) Energy source can be classified as exhaustible and inexhaustible sources of energy on the basis of the rate of consumption and replenishment:
If the rate of consumption is higher than the rate of replenishment, then the source of energy is exhaustible.
If the rate of consumption is lower than the rate of replenishment, then the source of energy is inexhaustible.
The options given in (a) and (b) are essentially the same.

22. What are the qualities of an ideal source of energy?

Ans. An ideal source of energy should possess the following characteristics.
(a) It should be capable of giving an adequate amount of useful energy.
(b) It should be convenient to transport, store and use.
(c) It should be economical.
(d) It should be capable of supplying the desired quantity of energy at a steady rate over a long period of time.

23. What are the advantages and disadvantages of using a solar cooker? Are there places where solar cookers would have limited utility?

Ans. The use of a solar cooker has the following advantages.
(a) It saves fuel.
(b) It does not produce smoke. Therefore, it does not cause any air pollution.
(c) The food cooked in a solar cooker retains its nutritive value. This is because, in a solar cooker, the food is cooked at relatively much lower temperature.
(d) Cooking by using a solar cooker saves time.

A solar cooker gets energy direct from the sun. Therefore, it cannot be used when and where there is no sunlight.

24. What are the environmental consequences of the increasing demand for energy? What steps would you suggest to reduce energy consumption?

Ans. (i) Burning of fossil fuels to meet increasing demand for energy causes air-pollution.

(ii) Construction of dams on rivers to generate hydroelectricity destroys large ecosystem-which get submerged under water in the dams. Further, large amounts of methane (which is a greenhouse gas) is produced when submerged vegetation rots under anaerobic conditions.

In order to reduce energy consumption:

(a) Fossil fuels should be used with care and caution to derive maximum benefit out of them.

(b) Fuel saving devices such as pressure cookers etc. should be used.

(c) Efficiency of energy sources should be maintained by getting them regularly serviced.

(d) And last of all, we should be economical in our energy consumption as energy saved is energy produced.

NCERT EXEMPLAR PROBLEMS-SOLUTIONS

Multiple Choice Questions (MCQs)

1. Which of the following is a non-renewable source of energy?

(a) Wood (b) Sun

(c) Fossil fuels (d) Wind

Ans. **(c)** Non-renewable sources of energy are those which are exhaustible and cannot be replaced, once they have been used.

Non-renewable sources of energy also known as conventional sources of energy. The fossil fuels are non-renewable sources of energy whereas wood, the sun and wind are renewable sources of energy.

2. Acid rain happens because

(a) sun leads to heating of upper layer of atmosphere

(b) burning of fossil fuels release oxides of carbon, nitrogen and sulphur in the atmosphere

(c) electrical charges are produced due to friction amongst clouds

(d) the earth atmosphere contains acids

Ans. **(b)** Acid rain happens because of several human activities of polluting the atmosphere. The emission of carbon, sulphur and nitrogen from the industries, burning of fossil fuels, etc., and also by the natural phenomena such as emission from volcanoes make the water vapour in the cloud more acidic thereby causing acid rain.

3. Fuel used in thermal power plants is

(a) Water (b) Uranium

(c) Biomass (d) Fossil fuels

Ans. **(d)** The thermal power plant generates electric power from heat produced by burning fossil fuels i.e., coal and petroleum. Every day we burn large amount of fossil fuels to heat up water to produce steam. The steam so produced runs turbines to generate electricity.

4. In a hydro power plant

(a) potential energy possessed by stored water is converted into electricity

(b) kinetic energy possessed by stored water is converted into potential energy

(c) electricity is extracted from water

(d) water is converted into steam to produce electricity

Ans. (a) In a hydro power plant, water from the top of the dam is allowed to fall through pipelines over the blades of turbine at the bottom of the dam. In this process, the potential energy of water changes into its kinetic energy which is transferred to the turbine.

The moving turbine rotates the armature of a generator to produce electricity i.e., turbine changes the kinetic energy into electricity. Thus, potential energy possessed by stored water is converted into electricity.

5. Which is the ultimate source of energy?

(a) Water (b) Sun

(c) Uranium (d) Fossil fuels

Ans. **(b)** The sun is considered as the ultimate source of energy to r several reasons. The main reason is that all form of energy, directly or indirectly is derived from sun. Without the sun, no food (meat or plant based) would grow and thus, we would not be able to gain the energy needed to live.

6. Which one of the following forms of energy leads to least environmental pollution in the process of its harnessing and utilization?

(a) Nuclear energy (b) Thermal energy

(c) Solar energy

(d) Geothermal energy

Ans. **(c)** Solar energy leads to least environmental pollution in the process of its harnessing and utilization. In nuclear energy, emission of radiation is a high risk for environmental contamination.
In thermal energy, heat produced by burning fossil fuels causes huge environmental pollution. In geothermal energy, noise pollution is created by drilling operations at geothermal sites.

7. Ocean thermal energy is due to
(a) energy stored by waves in the ocean
(b) temperature difference at different levels in the ocean
(c) pressure difference at different levels in the ocean
(d) tides arising out in the ocean

Ans. **(b)** The water at the surface of the sea or ocean is heated by the sun while the water in deeper sections is relatively cold. This difference in temperature between these layers ranges from 10°C to 30°C is exploited to obtain energy. Thus, ocean thermal energy is due to temperature difference at different levels in the ocean.

8. The major problem in harnessing nuclear energy is how to
(a) split nuclei
(b) sustain the reaction
(c) dispose of spent fuel safely
(d) convert nuclear energy into electrical energy

Ans. **(c)** The major hazard of nuclear power generation is the storage and disposal of spent or used fuels. Improper nuclear-waste storage and disposal result in environmental contamination, as well as, risk of accidental leakage of nuclear radiation.
It happened in Chernobyl disaster 1986, Fukushima Nuclear disaster 2011 caused great damage to the living beings and habitats.

9. Which part of the solar cooker is responsible for greenhouse effect?
(a) Coating with black colour inside the box
(b) Mirror
(c) Glass sheet
(d) Outer cover of the solar cooker

Ans. **(c)** Glass sheet present in the solar cooker easily passes the radiation into the solar cooker and these radiation get absorbed and reflected back by the black coating is of longer wavelength and can't pass back out through the glass. Thus glass sheet produces greenhouse effect in solar cooker.

10. The main constituent of biogas is
(a) methane (b) carbon dioxide
(c) hydrogen (d) hydrogen sulphide

Ans. **(a)** The composition of biogas is
(i) methane (CH_4), 65-75% (combustible).
And other constituent of biogas are as follows
(ii) carbon dioxide (CO_2), 20-30% (non-combustible)
(iii) hydrogen (H_2), 5-10% (combustible)
(iv) hydrogen sulphide (H_2S), traces (combustible)
(v) nitrogen (N_2), 2-6% (non-combustible)
Thus. the main constituent of biogas is methane.

11. The power generated in a windmill
(a) is more in rainy season since, damp air would mean more air mass hitting the blades
(b) depends on the height of the tower
(c) depends on wind velocity
(d) can be increased by planting tall trees close to the tower

Ans. **(c)** Wind energy farms can be located only in vast open areas located in favourable wind conditions as the minimum velocity for a windmill to function is 11 km/h to 16 km/h and is called as cut-in speed. Thus, the power generated in a windmill depends on wind velocity.

12. Choose the correct statement
(a) Sun can be taken as an inexhaustible source of energy
(b) There is infinite storage of fossil fuel inside the earth
(c) Hydro and wind energy plants are non-polluting sources of energy
(d) Waste from a nuclear power plant can be easily disposed off

Ans. **(a)** The sun has been radiating an enormous amount of energy at the present rate for nearly 5 billion years and will continue radiating at that rate for about 5 billion years more, so, the sun can be taken as an inexhaustible source of energy.

13. In a hydroelectric power plant more electrical power can be generated if water falls from a greater height because
(a) its temperature increases
(b) larger amount of potential energy is converted into kinetic energy
(c) the electricity content of water increases with height
(d) more water molecules dissociate into ions

Ans. (b) In a hydroelectric power plant more electrical power can be generated if water

falls from a greater height because the rise in water level, causes the increase in potential energy of water.

Thus when it flows from higher position more amount of kinetic energy is formed by the conversion of higher potential energy and this kinetic energy in the form of moving water can produce more electrical power.

14. Choose the incorrect statement regarding wind power.

(a) It is expected to harness wind power to minimum in open space

(b) The potential energy content of wind blowing at high altitudes is the source of wind power

(c) Wind hitting at the blades of a windmill causes them to rotate. The rotation thus achieved can be utilised further

(d) One possible method of utilising the energy of rotational motion of the blades of a windmill is to run the turbine of an electric generator

Ans. **(b)** To generate wind power, we require wind at a very high speed. Due to this motion it possess kinetic energy and as such they are capable of doing mechanical work by virtue of its motion.

The energy possessed by the wind is due to its high speed. When the blowing wind strikes across the blades of a windmill, it exerts a force on them due to which the blades of the windmill start rotating. This rotational motion of the blades is used to run the turbine of an electric generator. Thus, the option (b) is the incorrect statement.

15. Choose the incorrect statement.

(a) We are encouraged to plant more trees so as to ensure clean environment and also provide biomass fuel

(b) Gobar-gas is produced when crops, vegetable wastes etc., decompose in the absence of oxygen

(c) The main ingredient of biogas is ethane and it gives a lot of smoke and also produces a lot of residual ash

(d) Bio-mass is a renewable source of energy

Ans. **(c)** Encouraging to plant more trees we ensure clean and pollution free environment and it also provide bio-mass fuel. Gobar-gas is made from the decomposition of cow dung; crops, vegetable wastes, etc., decompose in the absence of oxygen.

The main ingredient of bio-gas is methane. It burns without smoke, leaves no residue like ash in wood, charcoal and coal burning. Bio-mass is living matter or its residues and is a renewable source of energy. Thus, part (c) is the incorrect statement.

Short Answer Type Questions

16. Why is there a need to harness non-conventional sources of energy? Give two main reasons.

Ans. There is a need to harness non-conventional sources of energy due of the following reasons

(i) The energy demands are increasing rapidly because of population explosion and our efforts to improve the quality of life by adopting faster means of transportation, rapid industrialization and extensive use of energy-fed appliances.

(ii) The sources of energy which are available are mainly fossil fuels which are non-renewable sources of energy and are limited. It will get exhausted after a time being. So, we need to harness non-conventional sources of energy.

17. Write two different ways of harnessing energy from ocean.

Ans. The two different ways of harnessing energy from ocean are as follows

(i) Tidal energy The energy derived from rising and falling ocean tides is called tidal energy. The tidal energy can be harnessed by constructing a tidal barrage or tidal dam across a narrow opening to the sea.

(ii) Ocean thermal energy Solar energy stored in the oceans in the form of heat is known as ocean thermal energy. Temperature differences between the deep ocean water and upper level is used to produce ocean thermal energy. The process of harnessing the thermal energy of the sea is called ocean thermal energy conversion.

18. What steps would you suggest to minimise environmental pollution caused by burning of fossil fuels?

Ans. The following steps can be would suggested to minimise environmental pollution caused by burning of fossil fuels

(i) Using smokeless appliances and using various techniques to reduce the escape of harmful! gases.

(ii) Converting land into forest by planting trees.

(iii) Using clean fuels like CNG, LPG, etc.

(iv) By using public transport instead of private vehicles.
(v) By increasing the efficiency of combustion process.

19. What is the role of a plane mirror and a glass sheet in a solar cooker?

Ans. The role of a plane mirror and a glass sheet in a solar cooker are as follows
(i) Plane mirror They are used as reflector in solar cookers to focus the maximum rays of the sun into the cooker to achieve a higher temperature.
(ii) Glass sheet The transparent glass sheet kept over the open end of the heating devices allows the infrared rays and visible rays to enter the device but does not allow the infrared radiations to move out of the heating device due to increase in the wavelength of radiation inside the cooker and the temperature of heating device rises appreciably.

20. Mention three advantages of a solar cell.

Ans. The three advantages of a solar cell are as follows
(i) Solar cell is pollution-free during use.
(ii) Its maintenance cost is very low and work quite satisfactorily without the use of any focusing device. It is also a ultimate source of energy.
(iii) It can be set up in remote and inaccessible hamlets or very sparsely inhabited areas in which laying of a power transmission line may be expensive and not commercially viable.

21. What is bio-mass? What can be done to obtain bio-energy using biomass?

Ans. The waste material of living things (cattle dung) and dead parts of plants and animals are called bio-mass. It has been a traditional source of energy, e.g., wood, crop residue, biogases (residue of sugarcane after extracting juice) cow-dung cake are used as fuels for domestic as well as industrial uses.
Bioenergy in the form of biogas can be produced from Biomass by the decomposition in the absence of air. Biomass such as wood, cow-dung etc, are directly used as fuel.

22. What are the limitations in obtaining energy from wind?

Ans. The limitations in obtaining energy from wind are as follows
(i) It can be established only at those places where wind blows whole of the year.
(ii) The minimum wind speed necessary for satisfactory working of a wind generator is 15 km/h, which is not gained continuously.
(iii) Wind energy farm requires quite large area of land nearly 2 hectares lend is needed for 1 MW generator.
(iv) The setting up of wind energy farm is very expensive.
(v) As the blades are exposed to vagaries of nature like rain, the sun, storm and cyclone, they need high level of maintenance.
(vi) The wind energy farms disturb rainfall pattern.

Long Answer Type Questions

23. Which is the process used to harness nuclear energy these days? Explain it briefly.

Ans. Nuclear reactor is the process used to harness nuclear energy these days. Nuclear fission reaction takes place in the nuclear reactor. The reaction in which a heavy nucleus splits into two or more smaller nuclei with the evolution of large amount of energy, when it is bombarded with slow moving neutron is called nuclear fission.
The nucleus of a heavy atom (such as uranium, plutonium or thorium), when bombarded with low energy neutrons, can be split apart into lighter nuclei along with the release of tremendous amount of energy. U-235 nucleus splits up broadly into two groups of nuclei
(i) A heavy group of nuclei, with mass number in the range A = 130 to A = 149,
() A light group of nuclei, with mass number in the range A = 85 to A = 104.
In the form of a nuclear reaction, we represent nuclear fission of U-235 as follows

$$^{235}_{92}U \xrightarrow[Slow\,moving]{^{1}_{0}n} {}^{236}_{92}U \longrightarrow {}^{144}_{56}Ba + {}^{89}_{36}Kr + 3{}^{1}_{0}n +$$

Energy (in huge amount)
The major hazards of nuclear power generation are as follows
(i) The improper nuclear-waste storage and disposal may result into environmental contamination.
(ii) There is a risk of accidental leakage of nuclear radiation and its leakage causes huge loss to living things.
(iii) The high cost of installation of a nuclear power plant and high risk of environmental contamination and limited availability.

24. How can solar energy be harnessed? Mention any two limitations in using solar energy. How are these limitations overcome?

Ans. Solar energy can be harnessed directly as well as indirectly which are as follows

(i) **Direct utilisation** The direct utilisation of solar energy can be done either by collecting it as heat (solar cooker, solar heater) or by converting it to electricity (solar cells).

(ii) **Indirect utilisation** It can be done by converting solar energy into chemical energy like bio-mass of plants, etc.

The limitations in using solar energy are as follows

(i) Energy reaching the surface is very much diffused so, direct utility is limited,

(ii) It is not available uniformly all the time and at all the places.

(iii) It is not available in night.

(iv) It is not available on a cloudy day.

These limitations of using solar energy are overcome by using solar cells that convert solar energy into electricity.

25. Make a list of conventional and non-conventional sources of energy. Give a brief description of harnessing one non-conventional source of energy.

Ans. The following are the list of conventional and non-conventional sources of energy

(i) **Conventional sources of energy** They are those which are used extensively and meet a major portion of our energy requirement. These are fossil fuels (wood, coal and petrol), hydro energy, biomass energy and wind energy.

(ii) **Non-conventional sources of energy** They are those which are not used as extensively as conventional ones and meet our energy requirement only on a limited scale. These are solar energy, ocean energy (tidal energy, wave energy and ocean thermal energy), geothermal energy and nuclear energy,

The harnessing of one non-conventional source of energy is as follows

Nuclear energy Nuclear energy is produced by the release of heat from unstable elements such as uranium. The energy is harnessed by using the energy to heat water.

The radioactive water is then pumped through a heat exchanger where the dirty water is used to heat clean water. The clean water can then be used to drive turbines and other forms of engine.

26. Why is there a need for harnessing non-conventional sources of energy?

How can energy be harnessed from the sea in different ways?

Ans. There is a need for harnessing non-conventional sources of energy because of following reasons

(i) The demand for energy is increasing day-by-day to meet out the basic requirement of our changed life-styles, growing use of machines and industrialisation in order to improve our living standards.

(ii) The fossil fuels are non-renewable sources of energy and were formed over millions of years ago and there are only limited reserves of fossil fuels.

The energy from the sea can be harnessed in the different forms are as follows

(i) **Tidal energy** It is harnessed by constructing a dam across a narrow opening to the sea, A turbine fixed at the opening of the dam converts tidal energy to electricity.

(ii) **Wave energy** A wide variety of devices have been developed to trap huge waves near the seashore for rotation of turbine and production of electricity.

(iii) **Ocean thermal energy** The water at the surface of the sea or ocean is heated by the sun while the water in deeper sections is relatively cold. This difference in temperature is exploited to obtain energy in ocean thermal energy conversion plants. These plants can operate if the temperature difference between the surface water and water at depths up to 2 km is 293 K (or 20°C) or more.

The warm surface water is used to boil a volatile liquid like ammonia. The vapours of the liquid are then used to run the turbine of the generator. The cold water from the depths of the oceans is used to condense vapour again to liquid.

The devices used to harness this form of ocean energy are known as Ocean Thermal Energy Conversion [OTEC] power plants.

27. What are the environmental consequences of using fossil fuels? Suggest the steps to minimise the pollution caused by various sources of energy including non-conventional sources of energy causes global warming.

Ans. The environmental consequences of using fossil fuels are as follows

(i) The air pollution caused by burning of coal or petroleum products.

(ii) The oxides of carbon, nitrogen and sulphur that are released on burning fossil fuels are acidic oxides. These lead to acid rain which affects our water and soil resources.

(iii) The generation of greenhouse effect of gases like carbon dioxide leading to global warming.

The following are the steps to minimise the pollution caused by various sources of energy including non-conventional sources of energy

(i) The pollution caused by burning fossil fuels can be reduced by increasing the efficiency of the combustion process and using various techniques to produce the smokeless appliances.

(ii) The air pollution caused by burning of coal or petroleum products can be reduced by forestation.

(iii) The planned and judicious use of energy can minimise the pollution e.g., use of Liquid Petroleum Gas (LPG) and Compressed Natural Gas (CNG) as domestic fuel and transportation vehicles.

(iv) Proper and safe disposal of nuclear wastes.

28. Energy from various sources is considered to have been derived from the sun. Do you agree? Justify your answer.

Ans. Yes, Sun is the ultimate source of energy directly or indirectly, all the forms of energy are derived from solar energy. Because of the following reasons

(i) **Non-renewable sources of energy** Fossil fuels like coal, petroleum and natural gas are formed due to burial of large plants and ancient creatures whose ultimate source of energy is the sun.

(ii) **Renewable sources of energy** They are indirectly derived from solar energy such as

(a) **Energy from flowing water** Clouds are formed when water in lakes, rivers, seas, etc., evaporate due to solar energy. They bring rainfall and snowfall. The rain and melting snow feed rivers, streams, etc. This flowing water can be used for getting hydroelectricity.

(b) **Wind energy** Wind energy arises due to uneven heating of the earth's surface by the sun rays at two different adjoining places. Due to this, a pressure difference is created and wind possesses kinetic energy.

(c) **Bid-energy** Plants in the process of photosynthesis converts the solar energy into food (chemical energy). This food is consumed by animals. Thus, the animal wastes and remains of the plants constitute bio-mass which can be utilised as a source of energy.

(d) **Wave energy** The waves are generated by strong winds (due to solar energy) blowing across the sea,

(c) **Ocean thermal energy** Sun is responsible for the temperature difference between the water at the surface and water at depth in seas and oceans.

(iii) **Solar heating devices** They derive their energy directly from solar energy and convert it into other usable forms of energy. Thus, the energy from various sources are considered to have been derived from the sun.

29. What is bio-mass? Explain the principle and working of a biogas plant using a labelled schematic diagram.

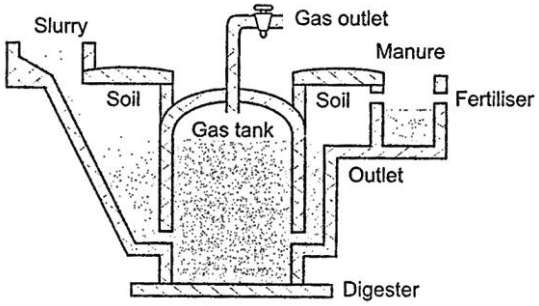
Ans. Bio-mass refers to the organic fuel obtained from plants and animal wastes like wood, cow-dung, residue after harvesting the crop, vegetable waste and sewage, etc. It has been used as a fuel for a long time. These fuels, however, do not produce much heat on burning and a lot of smoke is given out when they are burnt.

Bio-energy can be produced in a plant, known as 'bio-gas plant or gobar-gas plant' using bio-mass like cow-dung, various plant materials like the residue after harvesting the crops, vegetable waste and sewage are decomposed in the absence of oxygen to give bio-gas.

The labelled diagram of 'gobar gas'' plant is given below

Principle

It is based on the principle that the anaerobic micro-organisms decompose or breakdown complex compounds of the cow-dung slurry, in absence of oxygen, in a few days and generate gases like methane, carbon dioxide, hydrogen and hydrogen sulphide which burn without smoke and leaves no residue like ash.



Working The plant has a dome-like structure built with bricks. A slurry of cow-dung, various plant materials like the residue after harvesting the crops, vegetable waste, sewage and water is made in the mixing tank from where it is fed into the digester. The digester is a sealed chamber which is free from oxygen.

Anaerobic micro-organisms decompose or break down complex compounds of the cow-dung slurry in a few days and generate gases like methane, carbon dioxide, hydrogen and

hydrogen sulphide. The bio-gas is stored in the gas tank above the digester from which they are drawn through pipes for use,

EXERCISE

Multiple Choice Questions

1. Which one of the following does not relate to the solar energy?
(a) Nuclear energy (b) Wave energy
(c) Wind energy (d) Tidal energy

2. The major cause of environmental pollution is the use of
(a) Biomass energy (b) Fossil fuels
(c) Ocean energy (d) Hydrogen as a fuel

3. The coal reservoirs in our country are expected to last for another
(a) 1000 years (b) 250 years
(c) 400 years (d) 500 years

4. A tree usually matures in more than
(a) 15 years (b) 100 years
(c) 50 years (d) 60 years

5. The energy received by the Earth directly from the Sun is approximately which percentage of the Sun's total energy output?
(a) 0.00000005% (b) 0.00005%
(c) 1% (d) 0.001%

6. The approximate value of solar constant is
(a) 1.4 kW/m^2 (b) 1.4 kW/min
(c) 1.4 kJ/m^2 (d) 1.4 kW/min

7. The percentage of the solar energy reaching the Earth received by the plants is
(a) 10% (b) 0.1%
(c) 5% (d) 1%

8. An example of renewable source of energy is
(a) Sun (b) Natural gas
(c) Coal (d) Petroleum

9. What percentage of solar energy that strikes the periphery of the Earth is trapped by Earth?
(a) 15% (b) 100%
(c) 75% (d) 47%

10. The fraction of sunlight which consists of infrared radiation is
(a) $\frac{1}{4}$ (b) $\frac{2}{3}$ (c) $\frac{1}{2}$ (d) $\frac{1}{3}$

11. The heat in the sunlight is due to
(a) visible radiation
(b) entire solar radiation
(c) ultra-violet radiation
(d) infra-red radiation

12. Efficiency of modem solar cells is
(a) 60% (b) 25%
(c) 100% (d) 90%

13. The production of solar cookers on a commercial scale in India began in
(a) 1962 (b) 1980
(c) 1950 (d) 1970

14. A good fuel is one which possesses
(a) moderate ignition temperature
(b) high ignition temperature
(c) high calorific value
(d) both (a) and (c)

15. Which of the following variety of coal contains the highest percentage of carbon?
(a) Anthracite (b) Peat
(c) Lignite (d) Bituminous

16. The main constituent of natural gas is
(a) hydrogen (b) oxygen
(c) butane (d) methane

17. LPG consists mainly of
(a) butane (b) liquid hydrogen
(c) methane (d) ethane

18. The fraction of the total solar energy received by the Earth is
(a) one billionth (b) one millionth
(c) one hundredth (d) one thousandth

19. The approximate temperature of the surface of the Sun is
(a) 6000°C (b) 10,000°C
(c) 3000°C (d) 30,000°C

20. Which of the following is a primary fuel?
(a) Petrol (b) Diesel
(c) Kerosene (d) Wood

21. Which of the following is a secondary fuel?
(a) Diesel (b) Natural gas
(c) Wood (d) Coal

22. The device which harnesses solar energy directly is
(a) Solar cell (b) Biogas plant
(c) Coal gas plant (d) Natural gas plant

23. U-235 content in natural uranium is
(a) 99.2%. (b) 100%
(c) 0.006% (d) 0.714%

24. Energy released in the fission of one nucleus of U-235 is about
(a) 200 MeV (b) 2000 MeV
(c) 1 MeV (d) 20 MeV

25. Energy released in the fission of 1 kg of U-235 is equivalent to energy obtained from burning of coal weighing
(a) 2500 ton (b) 25000 ton
(c) 25 ton (d) 250 ton

26. One MeV of energy is equivalent to
(a) $1.6\times10^{13}\,J$ (b) $1.6\times10^{19}\,J$
(c) $1.6\times10^{-13}\,J$ (d) $1.6\times10^{-19}\,J$

27. One unified atomic mass unit (u) is equivalent to
(a) 931 MeV (b) 931 eV
(c) 1 eV (d) 1 MeV

28. Common moderator used in nuclear reactor is
(a) boron (b) uranium
(c) graphite (d) cadmium

29. Disposal of nuclear waste is a challenge because it is
(a) radioactive (b) foul smelling
(c) too large (d) too heavy

30. Uncontrolled nuclear chain reaction is the basis of
(a) hydrogen bomb (b) atom bomb
(c) nuclear reactor (d) none of these

31. If mass equivalent to one mass of proton is completely converted into energy then the energy produced is
(a) 931.49 MeV (b) 913.49 MeV
(c) 391.49 MeV (d) 931.49 MeV

32. Most of the fuels are
(a) carbon compounds with sulphur
(b) nitrogen compounds with carbon
(c) carbon compounds with hydrogen
(d) none of these

33. A nucleus breaks into two parts whose velocity is in ratio 2 : 1. The ratio of their radius is
(a) $1:2^{2/3}$ (b) $2^{2/3}:1$
(c) $1:2^{1/3}$ (d) $2^{1/2}:1$

34. Which of the following is a better nuclear fuel?
(a) Thorium - 236 (b) Uranium - 235
(c) Neptunium-239 (d) Plutonium - 239

35. When we use biomass to generate electricity we convert - energy locked in the biomass to electrical energy
(a) chemical (b) kinetic
(c) nuclear (d) muscular

36. The energy released per unit mass is
(a) more for fusion than for fission
(b) more for fission than for fusion
(c) equal for both fusion and fission
(d) varies from time to time

37. What sector of the Indian economy consumes most of the nation's petroleum?
(a) residential (b) commercial
(c) industrial (d) transportation

38. The ratio of radius of nuclei ${}_{13}Al^{27}$ and ${}_{52}Te^{125}$ is
(a) $\frac{3}{5}$ (b) $\frac{4}{5}$
(c) $\frac{2}{5}$ (d) $\frac{1}{5}$

39. Which among the following statement is not true about solar cooker?
(a) It saves fuel.
(b) It does not create pollution.
(c) The nutrients of food do not get destroyed.
(d) It cooks food quickly.

40. Which among the following is not a renewable source of energy?
(a) Wind energy (b) Ocean energy
(c) Solar energy (d) Fossil energy

41. Most of the energy we use originally came from
(a) the sun (b) the air
(c) the soil (d) the ocean

42. Electrical energy can be produced from
(a) mechanical energy (b) chemical energy
(c) radiant energy (d) all of the above

43. Coal, petroleum, natural gas, and propane are fossil fuels. They are called fossil fuels because
(a) they are burned to release energy and they cause air pollution
(b) they were formed from the buried remains of plants and tiny animals that lived hundred of millions of year ago
(c) they are nonrenewable and will run out
(d) they are mixed with fossils to provide energy

44. Natural gas is transported mainly by
(a) pipelines (b) trucks
(c) barges (d) all three equally

45. Global warming focuses on an increase in the level of which gas in the atmosphere?
(a) ozone (b) sulfur dioxide
(c) carbon dioxide (d) nitrous oxide

46. Solar, biomass, geothermal, wind, and hydropower energy are all renewable sources of energy. They are called renewable because they
(a) are clean and free to use
(b) can be converted directly into heat and electricity
(c) can be replenished by nature in a short period of time
(d) do not produce air pollution

47. Today, which renewable energy source provides the India with the most energy?
(a) wind (b) solar
(c) geothermal (d) hydropower

48. How much of the energy in burning coal reaches the consumer as electricity
(a) 1/3 (one-third) (b) 1/2 (one-half)
(c) 3/4 (three-quarters) (d) 9/10 (nine-tenths)

49. In a nuclear power plant, uranium atoms
(a) combine and give off heat energy

(b) split and give off heat energy
(c) burn and give off heat energy
(d) split and give off electrons

50. A substance which produces a log of heat on burning is called ____.
(a) oxidizing agent (b) biogas
(c) biomass (d) fuel

51. Fuel formed under the earth's surface by the decomposition of organic matter is called
(a) organic fuel (b) biogas
(c) fossil fuel (d) underground fuel

52. Which of the following causes the least pollution when burnt?
(a) Petrol (b) Diesel
(c) Coal (d) Natural gas

53. The radiations emitted by a hot furnace are
(a) ultra-violet (b) infra-red
(c) X-rays (d) microwaves

54. Which of the following is not combustible?
(a) oxygen (b) hydrogen
(c) butane (d) methane

55. Floating generators are used in the sea to harness
(a) tidal energy
(b) wave energy
(c) hydel energy
(d) energy from OTEC power plant

56. The molten material mixed with gases in the mantle of the earth is called
(a) core (b) lava
(c) geyser (d) magma

57. The scientist who first carried out critical nuclear fission reaction is
(a) Otto Hahn (b) Enrico Fermi
(c) Hans Bethe (d) Einstein

58. India exploded her first underground nuclear device at
(a) Kota (b) Ranchi
(c) Jaipur (d) Pokhran

59. The energy of a thermal neutron is about
(a) 0.025 eV (b) 0.25 eV
(c) 0.0025 eV (d) 0.00025 eV

60. Nuclear fusion reactions happens spontaneously in
(a) the core of the earth
(b) the commercial nuclear reactor
(c) the atmosphere of the sun
(d) the eruption of a volcano

FILL IN THE BLANKS

1. An area of 5 m^2 receive ..... solar energy for 2 hour if the solar constant is 1.4 kW m^{-2}.

2. A heap of wet wood if burnt, produces lot of smoke and leaves a residue. This residue is called.....

3. Biogas is a mixture of .....

4. The device used for obtaining energy from flowing water is called .....

5. ..... is the best fuel in terms of energy liberated per gram of fuel.

6. Coal gas is a mixture of ..... and .....

7. The efficiency of the modem solar cells from selenium is up to .....

8. Fly ash is used to make .....

9. Bright black variety of coal containing the highest carbon content is .....

10. The combustible components of biogas are..... and .....

11. ..... is a complex mixture of a large number of organic compounds.

12. Commercial unit of crude oil is .....

13. Renewable sources of energy are also called ..... sources of energy.

14. 1 calorie is ..... Joule.

15. The ratio of S.I. units to CGS units of energy is

16. Crude petroleum oil is refined by the process known as .....

17. ..... is obtained by distinctive distillation of wood.

18. ..... is added to LPG for detection of leakage.

19. The main component of LPG is .....

20. Calorific value of natural gas is .....

TRUE OR FALSE

1. A combustible substance serves as the food for fire.

2. Wood contains more moisture and volatile impurities than charcoal.

3. The solar energy is always available uniformly all the time and at all places.

4. Respiration is a slow combustion process.

5. The excessive use of solar energy will pollute the air.

6. Petroleum is a renewable source of energy.

7. Coal gas in an example of primary fuel.

8. Aerobic thermal degradation of wood is called carbonization.

9. One atom of uranium produces 10 times the energy produced by the combustion of an atom of carbon from coal.

10. The approximate value of solar constant is 1.4 J per second.

11. Bioenergy is the solar energy stored by the plants through photosynthesis.

12. Sources of energy which are inexhaustible are called chewable sources of energy.

13. The solar energy is the cause of wind and storm, ocean waves, rain and snowfall.

14. Tidal energy is an exhaustible and non-renewable source of energy.

15. Geothermal energy carried by natural geysers is utilized for generating electricity.

16. The earth surface absorbs about 34% of the total solar radiation reaching the top of the atmosphere.

17. The minimum wind velocity for a wind mill to function is 15 km h^{-1}.

18. Natural gas is not an environment friendly fuel.

19. Natural gas mainly consist of butane.

20. LPG is a byproduct of petroleum refining.

Matrix Match Type

In this section each question contains statements given in two columns which have to be matched. Statements (A, B, C, *D) in Column-I have to be matched with statements (p, a, r, s) in Column-II.*

1.

Column I	Column II
(A) Petroleum	(p) Plant nutrient
(B) Crude oil	(q) Wind mill
(C) Spent dung distillation	(r) Fractional
(D) Moving air	(s) Kerosene

2.

Column I	Column II
(A) Sewage	(p) Charcoal
(B) Wood	(q) Compressed natural gas
(C) Hydropower	(r) Methane gas
(D) Clean fuel	(s) Dam

3.

Column I	Column II
(A) Nuclear fission nuclear forces	(p) Involves weak
(B) Nuclear fusion	(q) Involves conversion of matter into energy
(C) β -decay	(r) Atoms of higher atomic number an used
(D) Exothermic nuclear reaction	(s) Atoms of lower atomic number are used

4.

Column I	Column II
(A) $\alpha-$decay	(p) ${}^{235}_{92}U+{}^{1}_{0}n\rightarrow {}^{141}_{56}Ba+{}^{92}_{36}Kr+3\left({}^{1}_{0}n\right)+Q$
(B) $\beta-$decay	(q) ${}^{3}_{1}H+{}^{2}_{1}H\rightarrow {}^{4}_{2}He+Q$
(C) Nuclear fission	(r) ${}^{230}_{88}Th\rightarrow {}^{226}_{88}Ra+{}^{4}_{2}He+Q$
(D) Nuclear fusion	(s) ${}^{137}_{55}Cs\rightarrow {}^{137}_{56}BaBa+e^{-}+\overline{V}+Q$

5.

Column I	Column II
(A) Coke	(p) Methane
(B) CNG	(q) Candles
(C) Paraffin wax	(r) Gasoline
(D) Petrol	(s) Carbon

ASSERTION & REASON QUESTIONS

Directions: In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it. Of the statements, mark the correct answer as

(a) *If both assertion and reason are true and reason is the correct explanation of assertion.*

(b) If both assertion and reason are true but reason is not the correct explanation of assertion.

(c) If assertion is true but reason is false.

(d) If assertion is false but reason is true.

1. **Assertion:** Biomass 'is not considered as an effective source of energy.
Reason: Biomass contains large proportions of water as moisture.

2. **Assertion:** Nuclear forces are independent of charges.
Reason: Nuclear force is not a central force.

3. **Assertion:** Binding energy (or mass defect) of hydrogen nucleus is zero.
Reason: Hydrogen nucleus contain only one nucleon.

4. **Assertion:** The rest mass energy of a nucleus is smaller than the rest mass energy of its constituent nucleons in Free State.
Reason: Nucleons are bound together in a nucleus.

5. **Assertion:** U^{235} nucleus, by absorbing a slow neutron undergoes nuclear fission with the evolution of a significant quantity of heat.
Reason: During nuclear fission a part of the original mass of U^{235} is lost and gets converted into heat.

6. **Assertion:** Charcoal needs lesser preheating than wood for burning.
Reason: The ignition temperature of charcoal is high.

7. **Assertion:** Aerobic thermal degradation of wood is termed as carbonization.
Reason: Wood under the affect of high temperature and pressure and *p* the absence of air gets converted in to coal.

8. **Assertion:** Non-renewable sources of energy are also called exhaustible source of energy.
Reason: Non-renewable sources of energy do not get exhausted by norm a human activity.

9. **Assertion:** Gases like carbon dioxide methane, nitrous oxide etc. are called greenhouse gases.
Reason: They are not responsible for the warming of the planet,

10. **Assertion:** Chemical reaction is a kind of nuclear reaction.
Reason: No new atom is formed during the reaction.

11. **Assertion:** Nuclear radiations are harmful because of their high ionization and penetrating powers.
Reason: If nuclear radiation fall on us, the molecules are ionised which disrupts the biochemical process.

12. **Assertion:** Nuclear fusion produce more energy than nuclear fission
Reason: The technical problems of achieving controlled fusion are however very much greater than with fission.

13. **Assertion:** The sun's energy comes from the fusion of hydrogen nuclei in to helium nuclei, which is going on inside it, all the time.
Reason: The nuclear fusion reaction taking place in the sun which releases a tremendous amount of energy is the fusion of 4 hydrogen atom nuclei to form a bigger nucleus of helium atom.

14. **Assertion:** Wind energy is an environment friendly and efficient source of energy.
Reason: Wind energy farms can be established everywhere.

15. **Assertion:** Solar cells are used to convert solar energy in to electrical energy.
Reason: The radiant heat present in solar energy does not change in to electrical energy.

PASSAGE

PASSAGE 1: Tokamak device is a device used in nuclear-fusion research for magnetic confinement of plasma. It consists of a complex system of magnetic fields that confine the plasma of reactive charged particles in a hollow, doughnut-shaped container. The tokamak (an acronym from the Russian words for toroidal magnetic confinement) was developed in the mid-1960s by Soviet plasma physicists. It produces the highest plasma temperatures, densities and confinement durations of any confinement device. It gives hopes for successful making of nuclear fusion reactor.

1. Which of the following statement about tokamak device is true?
(a) It is used in nuclear-fusion research for magnetic confinement of plasma.
(b) The acronym for tokamak is toroidal magnetic confinement.
(c) It is a simple device
(d) Both (a) and (b)

2. ..... is used in nuclear fission as moderator
(a) Graphite (b) Water
(c) Cadmium (d) Boron

3. Essential parts of a nuclear reactor are
(a) reactor core, steam generator steam throne and moderator
(b) reactor core, steam generator, steam turbine and steam condensing system
(c) reactor core, steam generator, coolant and moderator
(d) reactor core, steam generator coolant and steam condensing system

PASSAGE 2: Oceans cover about 70.8 per cent of the earth's surface and are the biggest source of rater on the earth. Due to the large mass of water oceans and high heat capacity of water, oceans act as a storehouse of energy. Apart from this, ocean water also possesses kinetic energy due to its tidal waves. There are various forms of energy stored in oceans.

1. Which is not a form of ocean energy which can be harnessed easily?
(a) Ocean thermal energy (b) Wave energy
(c) Tidal energy (d) Wind energy

2. The full form of OTEC is
(a) Ocean thermal energy conversion
(b) Ocean tide energy conversion
(c) Ocean tide energy conservation
(d) None of these.

3. The kinetic energy of the huge amount of water that moves along the waves is called
(a) Ocean wave energy
(b) Ocean thermal energy
(c) Ocean tidal energy
(d) Both (b) and (c).

PASSAGE 3: Natural gas is lighter than air and is a mixture of methane (about 95%), ethane, propane and butane. Other components found in natural gas include carbon dioxide, helium, hydrogen sulphide and nitrogen. It is highly inflammable and has no odour and cannot be seen. Therefore, before it is sent to the pipelines or storage tanks, it is mixed with a chemical that gives it a strong odour which is almost

like that of rotten eggs. This makes it easy to detect any leakage.

1. The cleanest burning fossil fuel is
(a) LPG (b) Natural gas
(c) CO_2 (d) CO

2. Which among the following is the most environment friendly fuel?
(a) Biogas (b) Natural gas
(c) Wood (d) Coal

3. The calorific value of natural gas is
(a) $40kJ\,g^{-1}$ (b) $45kJ\,g^{-1}$
(c) $50kJ\,g^{-1}$ (d) $55kJ\,g^{-1}$

SUBJECTIVE PROBLEMS

VERY SHORT ANSWER TYPE QUESTIONS

1. What are the environmental consequences of the increasing demand for energy? What steps would you suggest to reduce energy consumption?

2. What are the limitations of extracting energy from (a) the wind (b) waves (c) tides?

3. What are the advantages of nuclear energy?

4. The sue of dry wood as domestic fuel is not considered as good. State two reasons for it.

5. The surface area of a concentrator type solar cooker heater is 5 m^2. It reflects 80% of the radiation incident on it. Calculate the energy concentrated by the heater in 1 hour if the solar energy were delivered to it at the rate of 0.66 kW m^{-2}.

6. What are the advantages of coke over coal?

7. Why are many thermal power plants set up near coal or oil fields?

8. For producing electricity, the energy from flowing water is preferred to energy obtained by burning coke. State two reasons for it.

9. The use of dry wood as domestic fuel is not considered as good. State two reasons for it.

10. Which type of nuclear process is currently used in nuclear electricity generators? Give one example each for the substance used in this context as (i) coolants (ii) moderators and (iii) nuclear fuel?

11. How were fossil fuels formed? How these fossil fuels were made?

12. What is a solar cell? Name two materials mostly used for making solar cells.

13. Why is Nuclear fuel classified as renewable source of energy?

14. Mention two reasons why windmills will not serve as a source of energy in your area.

15. What is nuclear energy? Give its two uses for peaceful purposes.

16. Why do we use peat, the lowest grade of coal, for domestic purposes?

17. Which property of glass is employed in a greenhouse?

18. Why are the solar heating devices having parabolic reflector called solar concentrators?

19. Why is the solar cooker provided with a glass top?

20. What happens during carbonization of wood?

SHORT ANSWER TYPE QUESTIONS

1. 48 kJ of energy is produced per minute in a nuclear reactor. Calculate the number of fissions which would be taking place in the reactor per second, if the energy released per fission is 3.2 x 10^{-11} J.

2. Write the four processes that can take place, after neutrons are emitted in a fission reaction. Which of these processes will cause the fission to continue? How is the energy of released neutrons lowered from 2 MeV to 0.025 MeV?

3. (a) Why is solar cooker box covered with a plane glass plate?
(b) Why is the energy of water flowing in a river considered to be an indirect form of solar energy?
(c) Write one advantage of nuclear fission reaction

4. Solar energy can be harnessed by direct as well as indirect methods. Show that solar energy is the indirect source of wind and water energies.

5. Why is there so much emphasis on changing over from petro1/diesel-driven automobiles to CNG-driven vehicles?

6. Determine the power output of a $_{92}U^{235}$ reactor if it takes 30 days to use 2 kg of fuel. Energy released per fission is 200 Me V and N = 6.023 x 10^{26} per kilomole.

7. The binding energies per nucleon for deuteron ($_1H^2$) and helium ($_2He^4$) are 1.1 MeV and 7 MeV respectively. Determine energy released when two deutrons fuse to form a helium nucleon.

8. Determine the number of electrons, protons and neutrons in 8 g of $_6C^{12}$.

9. Calculate the energy released in the fission process

$$_{92}U^{235} +_0 n^1 \rightarrow_{56} B^{141} +_{36} Kr^{92} + 3_0 n^1 + Q$$

given $M(U^{235}) = 235.0439$ amu, $M(Ba^{141}) = 140.9129 M(Kr^{92}) = 91.8973$ amu, $m_n = 1.0087$ amu.

10. The energy released per fission of Uranium is 200 MeV. Determine the number of fission per second required to generate 2 MW power.

11. Calculate the number of protons and neutrons in $_{92}U^{238}$.

12. How much energy can be generated by complete fission of $350g$ of U^{235}? How much of coal would be needed to produce the same energy?

13. If 6.4 kJ energy is produced per minute in a nuclear reactor, find out the number of fissions that take place in it in one hour, given the energy released per fission is $3.2 \times 10^{-11} J$.

14. The number of protons in the nucleus of an element of mass number 35 is 17. What will be the number of neutrons in its isotope of mass number 37?

15. What are the limitations of solar energy?

LONG ANSWER TYPE QUESTIONS

1. The earth receives 1000 W of energy per sq. m. from the sun. If all this energy were to be absorbed by a bucket of water (30 kg) in half an hour, what would be the rise in temperature of water? Take, specific heat of water as $4.2 J\, kg^{-1}\ {}^{o}C^{-1}$.

2. Give the principle, construction and operation of a box type solar cooker.

3. The fission of one $U-235$ nucleus releases $3.2 \times 10^{-11} J$ of energy. Calculate the number of fissions required to produce energy at the rate of 5 MW for one day in a generator kept in a nuclear plant.

4. If 200 MeV energy is released per fission of U^{235} nuclei. Find the mass of U^{235} consumed per day in a reactor of power 1 MW assuming its efficiency as 80%.

5. When uranium undergoes fission, 0.1% of the total mass is converted into energy. Calculate the total amount of energy released in joule during an explosion of an atom which contains 5 kg of uranium.

6. What is the main basic cause for wind to low? Name a part of India where wind energy is commercially harnessed. Compare wind power and power of water flow in respect of generating mechanical and electrical energies. What is the hindrance in developing them?

7. Why is there a need of harnessing non-conventional sources of energy? How can energy be harnessed from the sea in different ways?

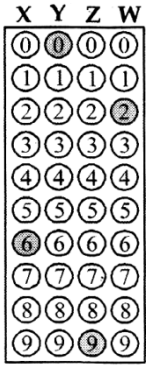
8. How can solar energy be harnessed? Mention any two limitations in using solar energy. How can we overcome these limitations?

9. What is biomass? Explain the principle and working of a biogas plant using a labelled schematic diagram.

10. What are nuclear hazards? Give some safety measures.

INTEGER ANSWER TYPE

This section contains 5 questions.
The answer to each of the questions is a single digit integer, ranging from 0 to 9.
If the correct answers to questions numbers X, Y, Z and W (say) are 6, 0, 9 and 2 respectively, then the correct darkening of bubbles will look like the following.



1. Energy released in the fission reaction of $^{235}_{92}U$ is $1.926 \times 10^{10} kJ\, mol^{-1}$. The energy released per kilogram of uranium fashioned is $x \times 10^{10} kJ$. Find the value of *x.*

2. The power output of a $^{235}_{92}U$ reactor if it takes 30 days to use 2 kg of fuel is $n \times 10^{7}$ W. Energy released per fission in 200 Me V and $N = 6.023 \times 10^{26}$ per kilo mole. Find the value of *n.*

3. Calculate the nuclear density in the order of 10^{17} if mass of nucleus is 1.67×10^{-27} and *R* of nucleus is 1.25×10^{-15}.

ANSWER – KEY

Multiple Choice Questions

1. A	**2.** B	**3.** B	**4.** A	**5.** A
6. A	**7.** D	**8.** A	**9.** D	**10.** C
11. D	**12.** B	**13.** A	**14.** D	**15.** A
16. D	**17.** A	**18.** A	**19.** A	**20.** D
21. A	**22.** A	**23.** D	**24.** A	**25.** A
26. C	**27.** A	**28.** C	**29.** A	**30.** B
31. A	**32.** C	**33.** C	**34.** B	**35.** A
36. A	**37.** D	**38.** A	**39.** D	**40.** D
41. A	**42.** D	**43.** B	**44.** A	**45.** C

46. C	**47.** D	**48.** A	**49.** B	**50.** D
51. C	**52.** D	**53.** B	**54.** A	**55.** B
56. D	**57.** B	**58.** D	**59.** A	**60.** C

Fill in the Blanks

1. 50400 kJ	**2.** Tar
3. CO_2+CH_4+H_2+H_2S	**4.** Water-wheel
5. Hydrogen	**6.** H_2, CH_4 and CO
7. 25%	**8.** Bricks
9. Anthracite	**10.** Hydrogen, methane
11. Petroleum	**12.** Barrel
13. Inexhaustible	**14.** 4.2
15. 10^7	**16.** Fractional distillation
17. Charcoal	**18.** Ethyl mercaptan
19. Butane	**20.** 55 kJ g^{-1}

True and False

1. True	**2.** True	**3.** False	**4.** True
5. False	**6.** False	**7.** False	**8.** False
9. False	**10.** False	**11.** True	**12.** True
13. True	**14.** False	**15.** True	**16.** False
17. True	**18.** False	**19.** False	**20.** True

Matrix Match Type

1.	A $\rightarrow$ r; B $\rightarrow$ s; C $\rightarrow$ p; D $\rightarrow$ q
2.	A $\rightarrow$ r; B $\rightarrow$ p; C $\rightarrow$ s; D $\rightarrow$ q
3.	A $\rightarrow$ q, r; B $\rightarrow$ q, s; C $\rightarrow$ p; D $\rightarrow$ q
4.	A $\rightarrow$ r; B $\rightarrow$ s; C $\rightarrow$ p; D $\rightarrow$ q
5.	A $\rightarrow$ s; B $\rightarrow$ p; C $\rightarrow$ q; D $\rightarrow$ r

Assertion & Reason

1. A	**2.** B	**3.** A	**4.** A	**5.** A
6. C	**7.** D	**8.** C	**9.** C	**10.** D
11. A	**12.** B	**13.** A	**14.** C	**15.** B

Passage Comprehension

Passage: 1

1. D	**2.** A	**3.** B

Passage: 2

1. D	**2.** A	**3.** A

Passage: 3

1. B	**2.** B	**3.** D

Integer Answer Type

1. 8	**2.** 6	**3.** 2