CHAPTER 14

Sources of Energy

EXAM DRILL

ANSWERS

1. Methane.

OR

Solar energy consists of electromagnetic waves (infrared radiation, visible radiation, ultraviolet radiation, X-rays, γ-rays etc.)

2. Anaerobic degradation : Breaking of large organic molecules into simple molecules in the absence of air is called anaerobic degradation.

3. It causes air pollution to the environment.

4. When the water from the ocean rises up, then it is called high tide and when it falls back it is called low tide.

5. **(b) :** Light nuclei is suitable for fusion process.

6. The fusion of two nuclei of heavy hydrogen or deuterium (^2_1H) is

$$^2_1H + {}^2_1H \longrightarrow {}^2_4He + {}^1_0n + 17.4 \text{ MeV}$$

OR

When wind strikes the blades a pressure difference is created between different regions which produces a turning effect and the blades are started rotating.

7. **(b) :** Wood has least calorific value among all these fuel.

8. **(d) :** The energy available due to difference in the temperature of water at the surface of the ocean and at the deeper level is called ocean-thermal energy.

9. **(a) :** An atom bomb is based on the principle of nuclear fission process.

OR

(d) : All of them can be used as a coolant in a nuclear reactor.

10. **(c) :** A hydrogen bomb is based on the principle of uncontrolled nuclear fusion process.

11. **(b) :** Wind energy farms can be established only where the minimum velocity of wind is 15 km h^{-1}.

OR

(d) : α-particle are helium nuclei.

12. **(a) :** The basic mechanism of power generation in tidal generator is the use of kinetic energy of flowing water to run the turbines for the production of electricity.

OR

(b) : Solar cells are usually made of semiconductors like silicon (Si), germanium (Ge) and gallium arsenide (GaAs).

13. **(a) :** LPG mainly consists of butane.

14. **(b)**

15. **(b) :** The sources of energy which have accumulated in nature over a very very long time and cannot be quickly replaced when exhausted, are called non-renewable source of energy. Renewable sources of energy is inexhaustible.

16. **(b)**

17. **(i) (d) :** Wind energy is not a form of ocean energy which can be harnessed easily.

(ii) (c) : Ocean thermal energy conversion uses the temperature difference between cold water and hot water to produce electricity.

(iii) (b) : The by-product in the OTCE is cold water. The amount of cold water will be in large quantity.

(iv) (c)

(v) (d) : Solar radiations.

18. **(i) (d) :** Solar energy is used for drying clothes, to preserve food items, cooking, etc.

(ii) (d) : Solar energy highly available on a sunny day.

(iii) (b) : Solar cell is a device which converts solar energy into electricity.

(iv) (a)

(v) (a) : Silicon is mainly used for making solar cell.

19. **(i) (a) :** According to pie-chart, coal is the fossil fuel is most widely used in India.

(ii) (c) : Methane is main constituent of natural gas.

(iii) (d) : Transportation sector consumes most petroleum.

(iv) (b) : They are formed from the buried remains of plants and animals that live hundreds of millions of years ago.

(v) (b)

20. **(i) (a)**

(ii) (b)

(iii) (c) : Energy output of sun is 4×10^{27} J/s.

(iv) (c) : In nuclear chain reaction the number of fission taking place goes on increasing at a rapid rate.

(v) (a) : Nuclear reactor is a device in which electricity is produced by the process of controlled nuclear fission reaction.

21. (i) Burning of dry dung-cakes causes air pollution while combustion of bio-gas does not produce any smoke.

(ii) Dung cakes leave a large quantity of ash and other residue after burning but bio-gas doesn't leave any residue after burning.

(iii) Cattle dung contains compounds of nitrogen and phosphorus and other important soil nutrients. Burning dung cakes destroys these nutrients whereas during the formation of bio-gas manuase is also produced.

(iv) The calorific value of cow-dung cakes are very much less than bio-gas.

OR

	Nuclear fission reaction	Nuclear fusion reaction
(i)	Decomposition of heavy nucleus into fragments.	Fusion of two light nucleus to form a heavy nucleus.
(ii)	Needs ordinary initiation temperature.	Initiation temperature are very high.
(iii)	Comparatively lower amount of energy is obtained.	Quantity of energy liberated is very high.

22. Uses of solar cells :

(i) Street lighting in rural areas,

(ii) Operating water pumps for domestic and agricultural purposes,

(iii) Operating radio and TV sets in remote/rural areas,

(iv) Lighthouse and offshore drilling rig operations.

23. Energy released by fission of one U-235 atom $= 3.2 \times 10^{-11}$ J

15 MW $= 15 \times 10^6$ J s^{-1}

$\therefore$ Energy produced per day $= 15 \times 10^6 \times 24 \times 60 \times 60$ J

$\therefore$ Required number of fission $= \dfrac{15 \times 10^6 \times 24 \times 60 \times 60}{3.2 \times 10^{-11}}$

$= \dfrac{12.96 \times 10^{11}}{3.2 \times 10^{-11}} = 4.05 \times 10^{22}$

OR

A nuclear reaction differs markedly from a chemical reaction. In a chemical reaction, only the electrons revolving around the nucleus take part in the reaction and no change occurs inside the nucleus whereas in a nuclear reaction, the nucleus itself undergoes a transformation. The energy changes involved in chemical reaction are much smaller than the energy changes involved in nuclear reactions.

24. The electricity generated during the day by a solar panel is utilised in charging storage batteries. These batteries operate the inverters during night which supply alternating current (ac) to run various electrical appliances.

25. 1 kWh $= 3.6 \times 10^6$ J

In order to provide 36 kJ of energy, the amount of fuel burnt = 1 g

$\therefore$ In order to provide 1 kWh, *i.e.*, 3.6×10^6 J of energy, the amount of fuel burnt

$= 1 \times \left(\dfrac{3.6 \times 10^6}{36 \times 10^3} \right) = 100 \text{ g} = 0.1 \text{ kg}$

26. Wave energy would be commercially viable only at places where the waves are strong.

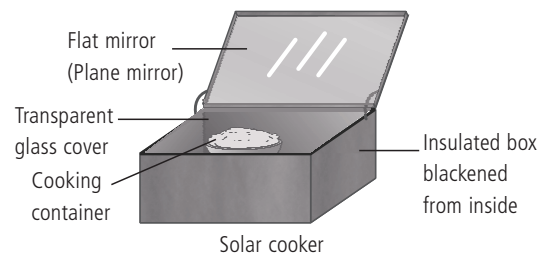
The energy produced from waves has to be transmitted through long distances to the place of use.

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.

27. The components of solar cooker, which are responsible for increase in the temperature inside the solar cooker, are : (a) transparent glass cover; (b) insulated box blackened from inside and (c) plane mirror.

Transparent glass cover helps in trapping of heat (infra-red radiation), blackened box helps in more absorption of heat and plane mirror helps to maximise the amount of sunlight on the food.



Solar cooker

OR

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 plant. These plants can operate if the temperature difference between the water at the surface and water at depths upto 2 km is 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 depth of the ocean is pumped up to condense vapour again to liquid.

The limitation in obtaining the energy from the oceans :

(i) Only a few selective sites are suitable for this purpose.

(ii) It does not possess enough energy to generate electricity on a large scale.

(iii) It is a time-consuming and costly process.

28. The four possible mistakes that may have occured during the construction and operation of the cooker are :

(i) the interior of solar cooker might not have been blackened,

(ii) plastic cover might have been used instead of glass cover,

(iii) the cooker might not have been properly insulated,

(iv) the cooking utensils might not have been blackened.

29. The average energy of a neutron produced in the fission of $^{235}_{95}U$ is about 2 MeV. These neutrons, unless slowed down, will escape from the reactor without interacting with the uranium nuclei. Therefore, it is necessary to slow down the fast neutrons by elastic scattering with light nuclei.

For slowing down neutrons, we prefer to use light nuclei so that neutrons may easily transfer their energy to these nuclei and slow down easily.

30. Wind is generated due to uneven heating of the earth by solar radiation. Thus, wind is an indirect source of solar energy. Heat energy of the sunlight evaporates water in oceans and lakes. This evaporated water goes into the atmosphere and returns back to the earth as rain water or snow. Rain water or melted snow takes the form of river/dam water. The kinetic energy of the flowing/stored water is used for producing electricity or for doing some mechanical work. Thus, ultimate source of water energy/hydroenergy is the energy of the sunlight (solar energy).

31. When a U-235 nucleus is bombarded by a slow neutron, it splits up into two medium sized nuclei along with the emission of an average of 2.5 neutrons. These neutrons can later cause nuclear fission of surrounding U-235 nuclei resulting in emission of more neutrons. Thus, one fission reaction triggers another fission reaction and at each successive stage, the number of fission taking place goes on increasing at a rapid rate. This is called a nuclear chain reaction.

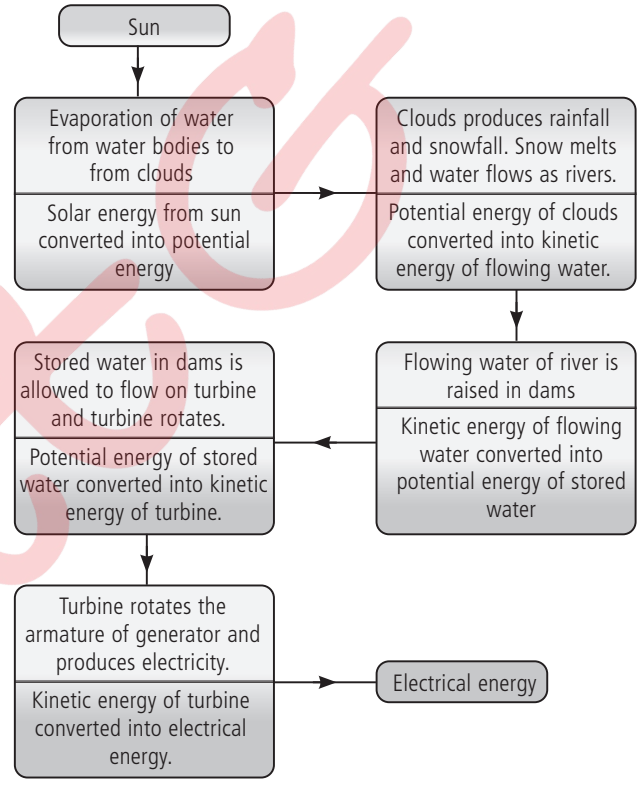
It is known experimentally that slow neutrons are much likely to cause fission in ^{235}U than fast neutrons. Also fast neutrons liberated in fission would escape instead of causing another fission reaction. Thus in order to slow down fast moving neutrons moderators are used. Also the reaction rate should be controlled throughout the reaction and is done using control rods.

32. Solar energy is stored as heat and kinetic energy in oceans. The forms of solar energy stored in oceans are

(i) sea wave energy

(ii) ocean thermal energy (OTE)

Both the forms can be harnessed to obtain energy in usable form.



33. The main differences between a box-type solar cooker and a spherical reflector type solar cooker are given below :

	Box-type solar cooker	**Spherical type solar cooker**
(i)	In the box-type solar cooker, a plane reflector is used. It does not concentrate solar energy at a point.	In the spherical reflector type solar cooker, a concave reflector or a parabolic reflector is used to concentrate the solar energy in a small region called focus.
(ii)	In the box-type solar cooker, 100-140°C temperature is produced.	A temperature of 200°C is easily produced in the spherical reflector type solar cooker.

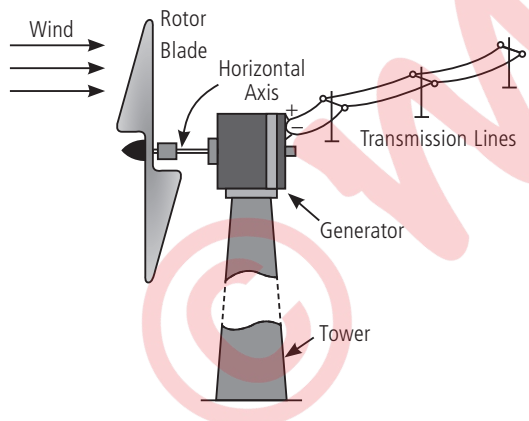
(iii)	Box-type solar cooker can be used for cooking only those food materials which require slow heating.	Spherical reflector type solar cooker can be used for cooking ever those food materials which require strong heating.
(iv)	Box-type solar cooker cannot be used for baking and frying.	Spherical reflector type solar cooker can be used for baking and frying also.

34. Principle and working of windmill : The design of the blades of a windmill is such that a pressure difference is created between its different regions when wind strikes them. This pressure difference produces a turning effect and makes the blades rotate about a horizontal axis. The rotational motion of the blades is then utilized to perform useful mechanical work or to generate electricity.

A windmill is used to :

(i) Pump water where the rotational motion of the windmill is utilized to do the mechanical work to operate a water-lifting pump.

(ii) Generate electricity where the rotational motion of the windmill is used to rotate the armature of an electric generator. Such an arrangement is called as a wind turbine generator as shown in figure.



OR

A power plant in which the heat required to make steam to drive turbines (to make electricity) is obtained by burning fossil fuels (coil, oil or gas) is called thermal power plant.

Fossil fuels are used to produce electricity. Coal (fuel oil or natural gas) is burned in a furnace to produce heat. This heat boils the water in a boiler to form steam. The steam formed from the boiling water builds up a pressure. The hot steam at high pressure is introduced into a turbine chamber having a steam turbine. The steam passes over the blades of the turbine as a high pressure jet making the turbine rotate. The shaft of turbine is connected to a generator. When the turbine rotates, its shaft also rotates and drives the generator. The generator produces electricity. The spent steam coming out of turbine chamber is cooled.

On cooling, steam condenses to form water. This water is again sent to the boiler to form fresh steam. This process is repeated again and again.

35. Some of the conventional sources of energy have poor efficiency and produce a lot of smoke due to incomplete combustion. For example,

Wood : As is well-known, wood is burnt in traditional chulhas. It has poor efficiency because only about 8% of the wood is utilised as fuel. Besides incomplete burning (combustion), it produces gases like carbon monoxide which are dangerous for health. It also leaves a lot of ashes.

Animal dung : Animal dung mixed with mud and made in the form of cakes and dried and burnt in many parts of the country for use for domestic purposes. As cowdung cakes are burnt inefficiently in the conventional manner, it produces a lot of smoke. Further as animal dung contains useful nutrients for soil, the burning of animal dung causes considerable wastage of useful elements, besides producing air pollution.

OR

(a) (i) Renewable sources : The energy derived from flowing water, wind, tides, ocean waves and bio-gas are the renewable sources. These sources can be harnessed into energy so long as the earth derives its heat and light from the sun or so long as the present solar system exists. Nuclear and geothermal energy is also likely to be available for a much longer time. Wood is another renewable source of energy. Though it takes almost 15 years for a tree to mature, this and nuclear energy are also classified as renewable sources.

(ii) Non-renewable sources : Fossil fuels like coal, petroleum and natural gas are non-renewable energy source. These are produced over millions of years due to slow changes and under special circumstances. These are not continuous processes and further it is not becoming possible to discover their new deposits. With the present rate of their consumption, it is estimated that known deposits of petroleum in our country will be exhausted in another 200 years and that of coal may last for another 250 years.

(b) Advantages of classifying energy sources as renewable or non-renewable are :

(i) It tells us which energy source should be used judiciously, that it could be used for maximum length of time, *e.g.*, non-renewable sources.

(ii) It promotes to develop newer methods to use a particular source economically, *e.g.*, renewable sources.

36. Differences between a nuclear fission and a nuclear fusion are given below :

	Nuclear fission reaction	**Nuclear fusion reaction**
(i)	Decomposition of heavy nucleus into fragments.	Fusion of two light nucleus to form a heavy nucleus.
(ii)	Needs ordinary initiation temperature.	Initiation temperature are very high.
(iii)	Comparatively lower amount of energy is obtained.	Quantity of energy liberated is very high.
(iv)	Products of fission reaction are generally radioactive.	Products of fusion reactions are not radioactive.
(v)	Controlled fission reaction are safely carried out to generate power.	Controlled fusion reaction is not yet achieved.
(vi)	Energy liberated in a nuclear reactor due to splitting of uranium nuclei.	Energy liberated in sun or explosion of hydrogen bomb due to fusion of hydrogen nuclei.

OR

Controlled thermonuclear reactions : A thermonuclear reaction, where the rate of reaction is controlled by external means is known as controlled thermonuclear reaction. If the energy released in a thermonuclear reaction is controlled in such a manner that a limited amount of energy is produced continuously, it can be used for many useful purpose, particularly for generation of electrical power.

It is very difficult to set up a sustained and controlled source of fusion. The easiest thermonuclear reaction that can be carried out on earth is the fusion of two deuterons ($d - d$ reaction) or fusion of a deuteron with a tritium ($d - t$ reaction).

$$_1^2H + _1^2H \longrightarrow _2^3He + _0^1n + 3.2 \text{ MeV} \qquad (d - d)$$

$$_1^2H + _1^2H \longrightarrow _1^3H + _1^1H + 4.0 \text{ MeV} \qquad (d - d)$$

$$_1^2H + _1^3H \longrightarrow _2^4He + _0^1n + 17.6 \text{ MeV} \qquad (d - t)$$

Deuterium, the source of deuterons for the above reaction, has a very small isotopic abundance about 1 part in 7000, but it is available in plenty in sea-water.

Essential requirements of a thermonuclear reactor : The requirements for a successful thermonuclear reactor are as follows :

(i) The temperature of the reactor should be high enough to overcome the electrostatic repulsion between the nucleus.

(ii) High pressure keeps the hydrogen atoms together. So high pressure should be maintained inside the reactor.

The energy produced by fusion is clean and is not accompanied by generation of any radioactive hazardous waste. Moreover, the fuel deuterium used in fusion is available in unlimited quantity in sea-water. Efforts are being made to achieve controlled thermonuclear fusion in laboratory. Once this happens, fusion will become the ultimate source of unlimited and unpolluted energy.

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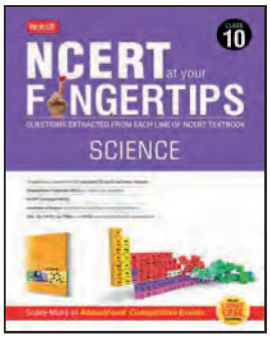

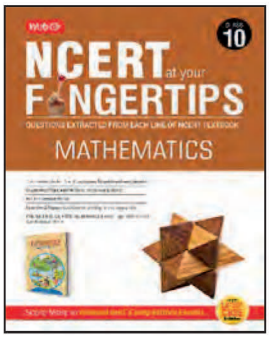

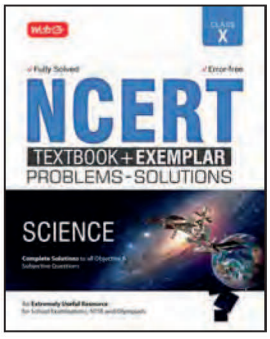

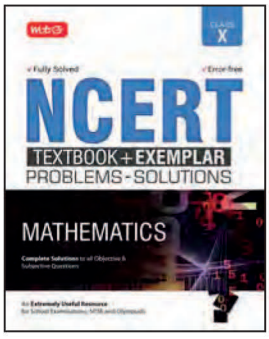

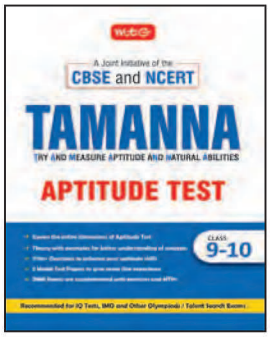

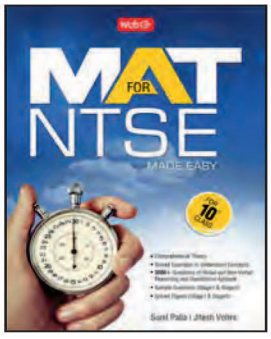

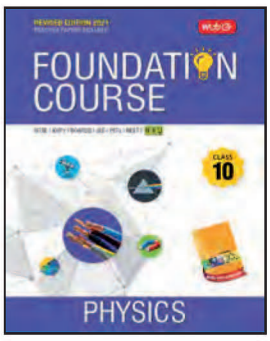

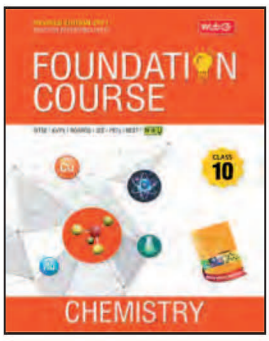

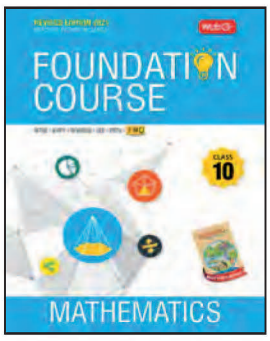

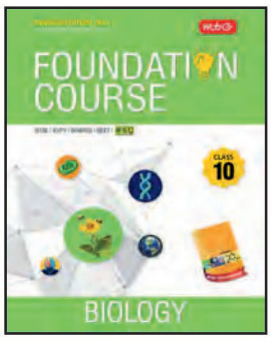

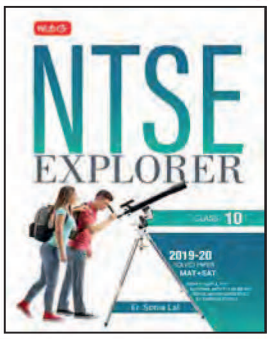

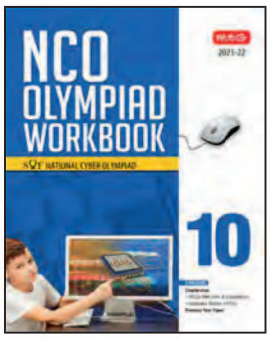

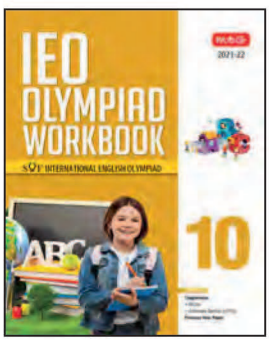

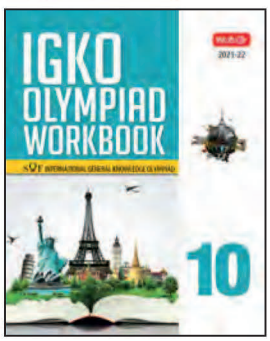

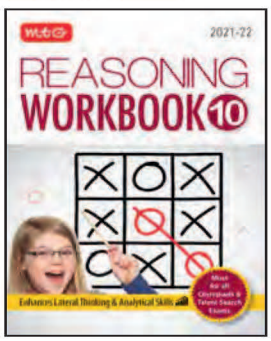

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