CHAPTER 6

Sources of Energy

Understanding Basic Concepts

- Energy is the ability to do work. The fact that a person is very energetic means he has a lot of energy. The amount of energy possessed by a body equals the amount of work it can do when its energy is released.
- The forms of energy are:
  (i) Mechanical energy (iv) Nuclear energy
  (ii) Heat energy (v) Electrical energy
  (iii) Chemical energy (vi) Solar energy
- Mechanical energy includes kinetic energy and potential energy. The energy possessed by a body due to its motion is called kinetic energy. The energy possessed by a body due to its position or configuration is called potential energy.
- The energy associated with a hot body is called heat energy or thermal energy. The energy produced by nuclear reactions is called nuclear energy. The energy produced by chemical reactions is called chemical energy. The energy associated with an electric current is known as electrical energy.
- The expression for kinetic energy is given by,

$$\text{K.E.} = \frac{1}{2} mv^2$$

  where m is mass of the body which is moving with velocity v.
  If the body is at rest, $v = 0$

$$\text{K.E.} = 0$$

- The expression for potential energy is given by

$$\text{P.E.} = mgh$$

  where m is mass of the body, g is acceleration due to gravity and h is its height above the surface of the earth.
  When the body is at the surface of the earth (even if it moves at the surface of the earth), its P.E. is zero as h is zero.
- The SI units for all forms of energy is joule and its symbol is J. The energy of a body is a scalar quantity.
- Man can use the energy stored in the muscles of his arms to do all the work. This stored energy comes from the chemical energy of the food which he eats. The major limitation of muscular energy is that its strength never remains the same all the time. Muscular energy is the most common form of energy which man has been using over the ages for going work.
- A simple machine is a device which is used to do work more conveniently and quickly. Examples: pulley, lever, inclined plane, screw, etc.
  The main advantages of using a simple machine are:
  (i) It reduces the effort needed to do a particular type of work or job.
  (ii) It transfers the point of application of the effort to some more convenient point.
  (iii) It can also change the direction of effort applied to some more convenient direction.
- The air in motion is often called wind. In other words, the moving air constitutes

wind. The wind possesses energy, which is purely kinetic energy.

- A sail refers to a sheet of thick cloth or canvas that is spread to catch the wind and move a boat. The sail boat is a simple machine which makes use of the energy of the wind for moving the boat.
- A wind-mill is a simple machine that works with the energy of the wind. The wind-mill can be used to run a pump to draw water from the ground. It can also be used to run a flour mill to grind grain. The labelled figures of a wind-mill being used to run a pump and a flour mill are shown in Fig. 6.1 and Fig. 6.2 respectively.

The most important use of energy is that it does not cause any pollution. Moreover, this energy is available free of cost. The only limitation of this energy is that it is not available all the time and at all places.

- Moving water also possesses kinetic energy. The water-wheel is a device used for obtaining energy from flowing water.
- The energy of naturally flowing water in high rivers is generally stored behind dams as potential energy and then further used to generate electricity. The electricity produced by using the energy of flowing water is known as hydroelectric power. The most important advantage of water energy

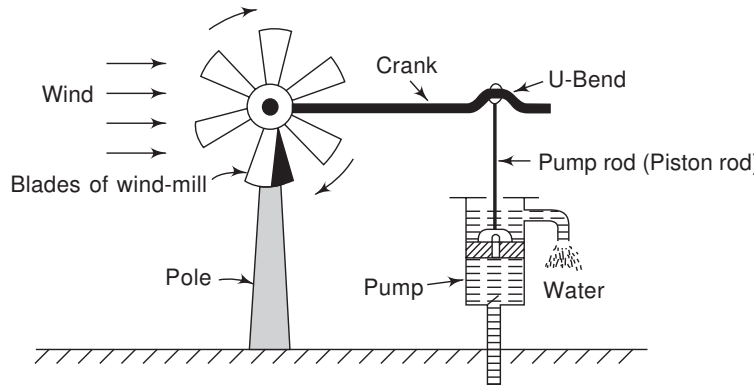


Fig. 6.1

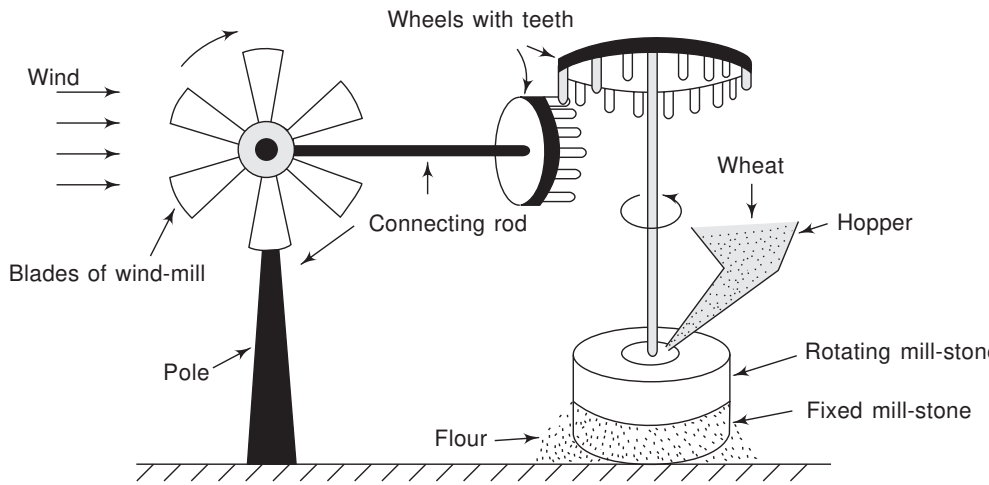


Fig. 6.2

is that like the wind energy it does not cause any pollution. An important limitation of this energy is that falling water is a not available in plenty everywhere to turn water-wheels and run the machines needed to generate electricity. The figure below shows the labelled diagram of a hydroelectric power station.

- The renewable sources of energy are those sources which are being produced continuously in nature and are inexhaustible. The important examples of renewable sources of energy are: wood, falling water, geothermal power, sun, wind, plants, tides, gobar gas, etc.

  The renewable sources are also known as non-conventional sources of energy.
- The non-renewable sources of energy are those sources which are accumulated in nature over a long time and can't be quickly replaced when they get exhausted. The important examples of non-renewable sources of energy are coal, natural gas, petroleum, uranium, etc.

  The non-renewable sources are also known as conventional sources of energy.
- The changing of one form of energy into another form(s) is known as transformation of energy. At a hydroelectric power station, the potential energy of water is transformed into kinetic energy and then into electrical energy. A steam engine converts the heat energy of steam into mechanical energy. At a thermal power station, the chemical energy of coal is transformed into heat energy and then into electrical energy. During a free fall, the kinetic energy is the transformation of potential energy initially possessed by the body before it falls.
- According to the principle of conservation of energy, when energy changes from one form to another, there is no gain or loss of energy. In other words, energy can neither be created nor destroyed, it can only be changed in form or transferred from one body to another body.
- The energy radiated by the sun is called solar energy. It is interesting to note that the solar energy received on the earth in one day is about 50,000 times more than the energy consumed by all the nations of the world in one year.
- There are two limitations of solar energy:

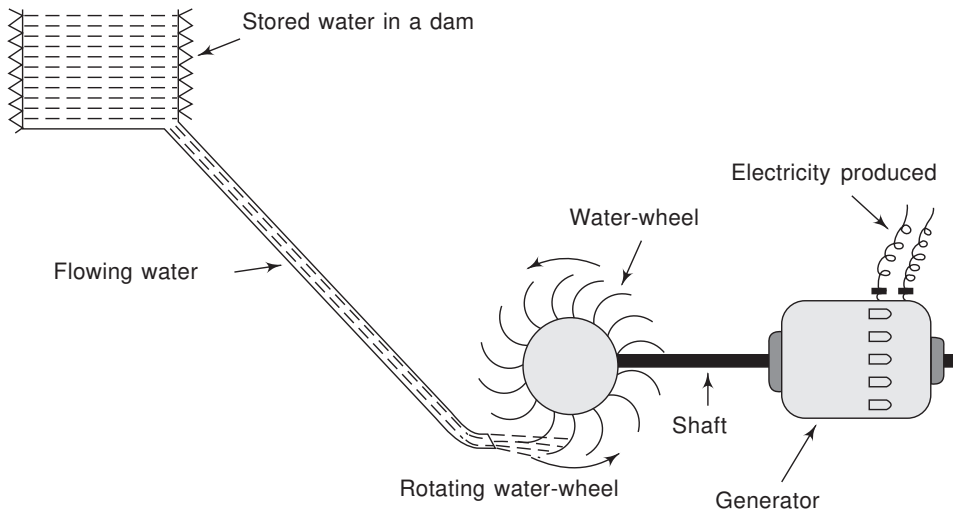


Fig. 6.3

(i) Solar energy that reaches the earth is in a very diffused form.

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

◆ Any device that gets heated by sun's energy is called a solar heating device. Such a device helps in collecting as much solar energy as possible. It is done by using a black pointed surface, a glass sheet cover and a reflector. The black painted surface absorbs much more heat as compared to a white reflecting surface. The hot body can lose its thermal energy by conduction, convection or radiation. In order to prevent the loss of heat, the black painted metal box is kept inside the insulated wooden box. The box is then covered with a transparent glass sheet. The glass sheet does not allow the infrared rays to go out of the box. Thus, the temperature inside the heating device rises due to these infrared rays. The reflector is used to increase the area over which solar energy is collected. Figure 6.4 shows the various parts of a solar heating device.

◆ A solar cooker is a heating device which is used to cook food by utilising the energy radiated by the sun. A solar heater is used to heat water by utilising the energy radiated by the sun. The solar power plants are used to produce electricity by using the solar energy. The solar calls are used to convert solar energy directly into electrical energy. The solar cells are made from semi-conductor elements like silicon and germanium.

◆ A solar furnace is a heating device which makes use of solar energy. Such a device can produce a very high temperature of about 3000°C.

◆ The efficiency of a solar heating device is much lower as compared to that of electric heating device. It is because the solar energy received by the heating devices is in a very diffused form.

◆ The major limitations of the solar heating devices are:

(i) The direction of the heating devices has to be changed after short intervals

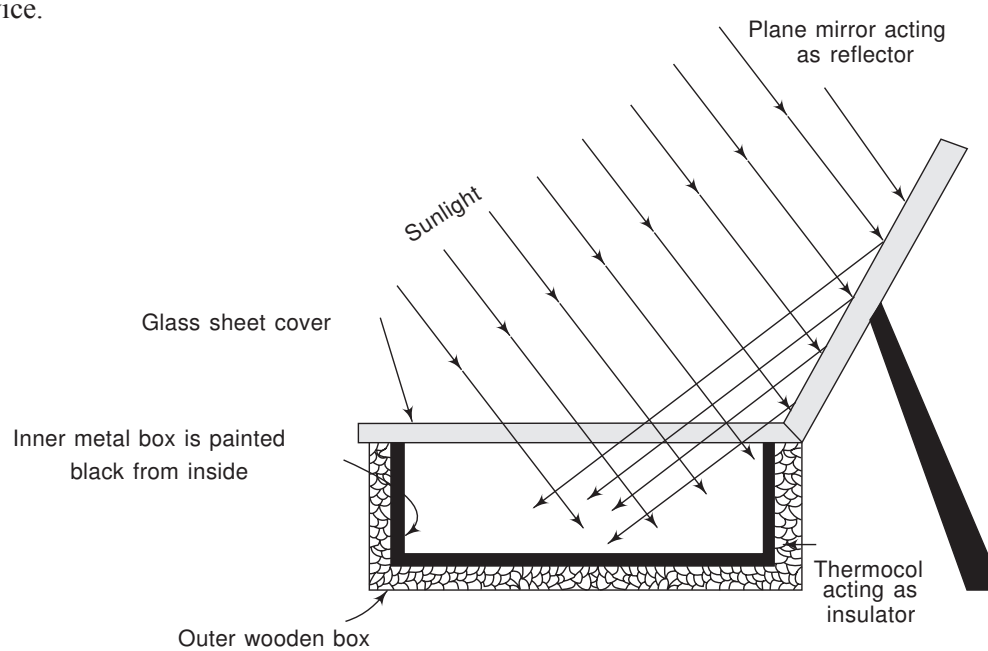


Fig. 6.4

of time, so that these devices keep facing the sun all the time.

(ii) They cannot be used during the night.

(iii) They cannot be used during the cloudy days.

- Oceans act as a storehouse of solar heat energy. As, oceans cover almost 71% of the earth's surface, they act as a vast collector of solar heat energy. The energy from the oceans is available in different forms. They are:
  (i) Ocean thermal energy (OTE)
  (ii) Sea-waves energy
  (iii) Tidal energy
  (iv) Energy from salinity gradient in seas
  (v) Energy from sea-vegetation
  (vi) Energy from the nuclear fusion of deuterium that is present in oceans
- There is always some significant temperature difference between the water 'at the surface of ocean' and 'at deeper levels'. This temperature difference is even up to 20°C at many places. This temperature difference enables the flow of heat. The energy available as a result of difference in the temperature of water at the surface of the ocean and at deeper levels is known as ocean thermal energy. It is also abbreviated as OTE.
- The rise of ocean water as a result of the moon's attraction is called 'high tide' and the fall of water is called 'low tide'. The rise and fall of tidal waves takes place twice a day. This gives rise to enormous movement of water between high tides and low tides and is an excellent source of energy in many coastal areas of the world. The tidal energy can also be harnessed by constructing some tidal barrier or tidal dams.
- Fuels which are directly used to produce heat are known as primary fuels, such as wood and coal. The fuels which are derived from primary fuels are secondary fuels, e.g., water gas, producer gas.
- Dry distillation of wood means burning the wood in an insufficient supply of air to remove volatile matter leaving behind a residue known as charcoal. Charcoal is considered a better fuel than wood, since it produces more smokeless heat (high calorific value) as compared to that generated by an equal amount of wood.
- Fossil fuels are derived from the remains of extinct life forms subjected to high temperatures and pressures in the absence of oxygen in the interiors of the earth over million of years, e.g., coal, petroleum.
  Fossil fuels are non-renewable energy sources. If exhausted, they cannot be replenished in a short time, as they were produced over millions of years.
- Coal is a complex mixture of compounds of carbon, hydrogen and oxygen, and some free carbon. A small amount of nitrogen and sulphur compounds are also found in coal.
- Carbonisation is the conversion of wood into coal by the slow chemical process which may take thousands of years to complete. Due to this, a number of intermediate products like peat, lignite, bituminous and anthracite have been obtained.
- Coal has three main varieties:
  (i) lignite (soft coal) (ii) bituminous coal (household coal) (iii) anthracite (hard coal).
- When coal is heated strongly in the absence of air, the process is called destructive distillation of coal. It gives rise to a number of organic and inorganic compounds. Coal gas, coal tar, coke and ammonia solution are the products of coal.
- Petroleum occurs deep down in the earth between layers of non-porous rocks. Crude oil petroleum is formed by the decomposition of animal and plant remains over millions of years inside the earth. Natural

gas occurs above the petroleum oil trapped under the rocks.

- The various products obtained on fractional distillation of petroleum are:
  (i) Petroleum gas
  (ii) Petrol or gasoline
  (iii) Diesel
  (iv) Kerosene
  (v) Fuel oil
  (vi) Lubricating oil
  (vii) Paraffin wax
  (viii) Asphalt
- LPG is liquified petroleum gas which mainly contains butane (along with small amounts of propane and ethane). LPG is obtained from fractional distillation of petroleum and also from natural gas.
  Advantage: It burns without emitting smoke.
  Disadvantage: It is highly inflammable.
- Petrochemicals are unsaturated gaseous hydrocarbons prepared by the processes such as cracking, cyclisation, oxidation etc. The common examples of petrochemicals are benzene, butadiene, ethylene, methyl alcohol, DDT and BHC.
- The fuels used in rockets are called rocket propellants. They contain both the fuels as well as the oxidiser for the fuel.
  Solid propellants:
  (i) Mixture of paraffin and KNO_3 (oxidiser)
  (ii) Thiokol rubber
  Liquid propellants:
  (i) Liquid hydrogen-liquid oxygen
  (ii) Liquid ammonia
- The differences between combustion and respiration are given below:

Combustion	*Respiration*
(i) It takes place at a much higher temperature.	(i) It takes place at a relatively low temperature.
(ii) It is a fast process and energy is released immediately in a single step.	(ii) It is a slow process and energy is released in a stepwise way.
(iii) It takes place outside the human body.	(iii) It takes place only in the living cells of our body.
(iv) Energy released is lost in the form of heat and light.	(v) Energy is stored in the form of ATP. The CO_2 and H_2O vapours are released through different organs of body.

- Characteristics of an ideal fuel are:
  (i) It should have a high calorific value.
  (ii) It should have a proper ignition temperature.
  (iii) It should not release poisonous gases.
  (iv) It should have a low cost and should be easily storable and transportable.
  (v) The fuel should be readily available most of the times.

SHORT ANSWER QUESTIONS (Based on Concepts)

1. What is SI unit of energy?

Ans. Joule (J)

2. What is the ratio of SI to cgs units of energy?

Ans. 1 J = 1 Nm

$= 1 \text{ kg ms}^{-2} \times \text{m}$

$= 1 \text{ kg m}^2 \text{ s}^{-2}$

$$\text{Required ratio} = \frac{1\text{kg m}^2\text{s}^{-2}}{1\text{g cm}^2\text{s}^{-2}}$$

$$= 10^3 \times (10^2)^2$$

$$= 10^7$$

3. What is source of energy?

Ans. It is the amount of energy which is capable of providing sufficient amount of useful energy at a steady rate over a long period of time. It must be kept in mind that the difference between output energy and input energy is called useful energy.

Useful energy = Output energy – Input energy

4. Renewable sources of energy are inexhaustible. Comment on the statement.

Ans. It means that these sources of energy are available in an unlimited amount in nature and reproduce within a very short period of time.

5. What are the main advantages of renewable sources of energy?

Ans. (i) They are freely available in nature.
(ii) They do not cause any pollution.
(iii) They will last as long as the earth receives light from the sun.

6. Is biomass energy non-renewable source of energy?

Ans. No, it is a renewable source of energy.

7. What are alternative sources of energy?

Ans. The sources of energy based on advances in technology to meet our growing needs are called alternative sources of energy. They are mainly non-conventional sources of energy.

8. Name the most abundant fossil fuel on the earth.

Ans. Coal. It is mainly carbon and is generally used as combustion fuel.

9. What are different varieties of coal?

Ans. Apart from peat, there are three other types of coal. They are:
(i) Lignite (ii) Bituminous
(iii) Anthracite

10. Which variety of coal has the richest carbon content?

Ans. Anthracite (94% – 98% carbon)

11. Is coke better fuel than coal?

Ans. Yes, coke is a better fuel than coal.

12. What is liquefied petroleum gas (LPG)?

Ans. The petroleum gas, on liquefaction, changes into a liquid which is called LPG. It is mainly used for cooking and hence it is also called cooking gas.

13. What are the chief constituents of LPG?

Ans. The main constituent of LPG is butane, though it contains ethane and propane in very small amounts.

14. What is the use of compressed natural gas (CNG)?

Ans. It is used as a fuel in transport vehicles. It is in liquid form and is a better alternative to petrol and diesel.

15. Name the cleanest burning fossil fuel. Is this fuel environmental friendly?

Ans. Natural gas is cleanest fossil fuel and is environment-friendly fuel.

16. What is bioenergy?

Ans. It is the energy obtained from biomass. The energy stored in the biomass is due to solar energy (which is about 1%) absorbed by the plants which convert it into chemical energy through photosynthesis.

17. Which form of energy is mainly responsible for the formation of winds?

Ans. Solar energy is one of the main factors responsible for the formation of winds.

18. Name the largest component of biogas.

Ans. Methane

19. What is the main component of LPG?

Ans. Butane

20. What is coal? How does it produce heat?

Ans. Carbon

It burns with oxygen to produce CO_2 and lot of heat. $C + O_2 \rightarrow CO_2 + \text{Heat}$

21. Which fuel has the largest calorific value?

Ans. Hydrogen (about 150 kJ/g)

22. What is slurry?

Ans. It is a mixture of animal dung and water in equal amounts.

23. Which country is called the 'country of winds'?

Ans. Denmark

It generates 25% of its electric power requirement from wind energy.

24. Is wood a renewable source of energy?

Ans. Yes, in case we plant trees in a planned manner for obtaining a continuous supply of wood.

25. What is gasohol?

Ans. It is a mixture of petrol and alcohol.

26. Name the most abundant fuel on earth.

Ans. Coal

27. What name is assigned to a cluster of windmills?

Ans. Wind energy farm

28. What is the minimum wind velocity for a windmill to function?

Ans. 15 km/h

29. Where is India's largest wind energy farm situated?

Ans. Kanyakumari (in Tamil Nadu)

30. Name the country that leads in harnessing the wind energy.

Ans. Germany

31. Name an important fossil fuel which is usually found underground near an oil source.

Ans. Natural gas

32. The use of dry wood as domestic fuel is not considered as good. Give two reasons for the same.

Ans. (a) It leaves lot of residue after burning.

(b) It produces lot of smoke after burning.

33. The sun is considered as a fusion reactor. Do you agree with it?

Ans. The sun is a source of solar energy which is caused due to fusion reactions inside the sun. So, it can be considered as a fusion reactor at a distance of 1.5×10^8 km from the earth.

34. Does the solar system receive the entire amount of solar energy?

Ans. The sun radiates energy in all directions in space. The earth and other planets of the solar system receive only a small fraction of this energy.

35. Does solar energy cause any air pollution?

Ans. No

36. Mention any two limitations of solar energy.

Ans. (i) Though solar energy is available in abundance, it is not evenly distributed on the earth. It cannot be made available when the sky is covered with clouds.

(ii) The equipment's and infrastructure needed to put solar energy to practical use are very expensive.

37. What is solar constant? Write its value in SI units.

Ans. It is the amount of solar radiation which is incident normally per second on 1 m^2 area of a perfectly black surface held at the mean distance of the earth from the sun.

The approximate value of solar constant is 1.4 kW/m^2.

38. Is solar constant a constant like the speed of light in vacuum (C)?

Ans. The solar constant is not a constant like gravitational constant (G), speed of light in vacuum (C), etc.

The value of solar constant ($S = 1.4$ kW/m^2) applies to the top of the atmosphere. The atmosphere reduces this value to 1 kW/m^2 on a clear day and a few W/m^2 on an overcast day on the earth's surface.

39. If the solar energy received in 2 minutes by 10 m^2 equals 4200 kJ, calculate the value of solar constant.

Ans. We have,

$$\text{Solar constant} = \frac{\text{Solar energy obtained}}{\text{Area} \times \text{time}}$$

$$= \frac{4200\,\text{KJ}}{10\,\text{m}^2 \times (5 \times 60)\,\text{s}}$$

$$= 1.4\ \text{kJ m}^{-2}\ \text{s}^{-1}$$

$$= 1.4\ \text{kW m}^{-2}$$

40. Calculate the amount of heat energy received by 5 m^2 on the earth's surface in 1 hour, assuming only 40 % of the solar energy strikes the earth's surface. Take $S = 1.4\ kW/m^2$.

Ans. Heat energy received on earth's surface
= 40% of solar constant × area × time

$$= \frac{40}{100} \times (1.4\ \text{kW/m}^2) \times 5\ \text{m}^2 \times (60 \times 60)\,\text{s}$$

= 10, 080, 000 J = 10, 080 kJ

41. What is solar energy device?

Ans. It is a device which uses solar energy directly as heat or converts it into electricity.

42. What is solar photovoltaic cell?

Ans. A solar cell is also called a solar photovoltaic cell.

43. The nutritional value of food prepared in solar cookers is very high. Why?

Ans. The vitamins contained in food are not destroyed in solar cookers, hence the nutritional value of food is very high.

44. What is concentrator type solar cooker? Can it be used to make 'Chapatis'?

Ans. A solar energy device which reflects and concentrates solar energy from over a large area into a small area is called a concentrator type solar cooker.

'Chapatis' cannot be prepared using a box-type solar cooker. However, they can be prepared using a concentrator type solar cooker.

45. Name the most commonly used material in the manufacture of solar cells.

Ans. Silicon

46. What is a solar cell panel?

Ans. A solar cell panel has a large number of solar cells which are joined together in a definite pattern.

47. What are OTEC power plants?

Ans. The solar energy stored in the oceans in the form of heat is called Ocean Thermal Energy (OTE). The process of generating the thermal energy of the sea is called Ocean Thermal Energy Conversion (OTEC) and the devices used for generating this energy are called OTEC power plants.

48. Which are the most common energies obtained from oceans?

Ans. (i) Tidal energy
(ii) Ocean thermal energy
(iii) Wave energy

49. What does an SPV stand for?

Ans. Solar photovoltaic cell

50. What is the range of temperature obtained by a concentrator type solar cooker?

Ans. 180°C to 200°C

51. What percentage of solar energy is absorbed by plants that reaches the earth?

Ans. 1%

52. What temperature can be generated by a solar furnace?

Ans. 3500°C

53. What is the approximate temperature difference between the warm layer and deep cold layer of sea water?

Ans. 10°C to 30°C

54. What is the average solar energy received by earth daily?

Ans. 4 kWh/m^2

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

Ans. It must be remembered that no source of energy is totally pollution free – only the degree of pollution varies. In fact, a solar cell produces energy which is pollution free but its assembly causes damage to environment.

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

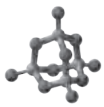
Ans. Hydrogen is a cleaner fuel than CNG. Hydrogen produces water on burning but CNG produces CO_2 on burning, though much less than that produced by coal or oil.
A space ship carries oxygen in liquid form to burn hydrogen (in liquid form) as a fuel.

57. Why is there a need to harness non-conventional sources of energy?

Ans. Our energy requirements are rapidly increasing because of (i) population explosion and (ii) our efforts to improve the quality of life. Moreover, fossil fuels (coal, petroleum, natural gas, LPG) are fast depleting.

58. Give two main steps to minimize environmental pollution caused by burning of fossil fuels.

Ans. (i) Planting more and more tress (afforestation)
(ii) Using smokeless appliances



SOLVED NUMERICAL PROBLEMS

Example 1 A horse and a dog are running with the same speed. If the horse weighs ten times as much as the dog, what is the ratio of their kinetic energy?

Solution

Kinetic energy (k_1) for the horse = $\frac{1}{2} m_1 v_1^2$

kinetic energy (k_2) for the dog = $\frac{1}{2} m_2 v_2^2$

Here m_1 and m_2 are the respective masses and v_1 and v_2 are their respective speeds.

$$\therefore \quad \frac{k_1}{k_2} = \frac{\frac{1}{2} m_1 v_1^2}{\frac{1}{2} m_2 v_2^2}$$

$$= \frac{m_1}{m_2} \quad (\because v_1 = v_2)$$

But $$\frac{m_1}{m_2} = 10 \text{ (Given)}$$

$$\frac{k_1}{k_2} = \frac{10}{1}$$

Thus, the required ratio of their kinetic energy is 10 : 1.

Example 2 Compute the kinetic energy of a body of mass 2 kg moving with a speed of 0.1 ms^{-1}.

Solution Given: $v = 0.1\ ms^{-1}$

$m = 2$ kg

$$\text{Kinetic energy } (k) = \frac{1}{2} mv^2$$

$$= \frac{1}{2} \times 2 \times (0.1)^2$$

$$= 0.01 \text{ J.}$$

Example 3 A person climbs a tower of height 72 m. If the person weighs 50 kg and g = 9.8 ms^{-2}, calculate the work done.

Solution

Given: $m = 50$ kg

$h = 72$ m

$g = 9.8\ ms^{-2}$

While climbing the tower, work is done against the gravity. Thus, work done equals potential energy.

Work done (W) = mgh

$= 50 \times 9.8 \times 72$ J

$= 35280$ J.

Example 4 A bag of wheat weighs 100 kg. To what height should it be raised so that its potential energy may be 9800 J? Take $g = 9.8\ ms^{-2}$.

Solution Given:

Potential energy, P.E. = 9800 J

m =100 kg

$g = 9.8\ \text{ms}^{-2}$

$h = ?$

We know, $\text{P.E.} = mgh$

or $$h = \frac{\text{P.E.}}{mg} = \frac{9800}{100 \times 9.8}$$

$$= 10\ \text{m.}$$

Example 5 A body of mass 1 kg when raised to a certain height above the ground stores the P.E. of 196 J. Find,

(i) the height to which the body has been raised.

(ii) using energy considerations, find the velocity of the body just before hitting the ground if it is allowed to fall freely. Take $g = 9.8\ \text{ms}^{-2}$.

Solution

(i) Given: $m = 1$ kg

$\text{P.E.} = 196$ J

$g = 9.8\ \text{ms}^{-2}$

We know, $\text{P.E.} = mgh$

$$\therefore \quad h = \frac{\text{P.E.}}{mg}$$

$$= \frac{196}{1 \times 9.8}$$

$$= 20\ \text{m.}$$

(ii) When the body just reaches the ground, the whole of P.E. changes into K.E.

$$\therefore \quad \frac{1}{2}\, mv^2 = mgh$$

$$\text{or} \quad \frac{1}{2}\, mv^2 = 196$$

$$\text{or} \quad \frac{1}{2} \times 1 \times v^2 = 196$$

$$\therefore \quad v = \sqrt{196 \times 2}$$

$$\simeq 19.7\ \text{ms}^{-1}.$$

Example 6 A body of mass 2 kg is thrown vertically upwards with a velocity of 20 ms^{-1}. Calculate:

(i) The K.E. at the time of projection.

(ii) The P.E. at the highest point and the height to which it will reach, assuming the acceleration due to gravity, $g = 10\ \text{ms}^{-2}$.

Solution Given: $m = 2$ kg

$v = 20\ \text{ms}^{-1}$

(i) K.E. of the body $= \frac{1}{2} \times 2 \times (20)^2$

$= 400$ J.

(ii) K.E. at the time of projection is equal to the P.E. at the highest point.

$$\therefore \quad \text{P.E.} = 400\ \text{J}$$

$$= mgh$$

$$\text{or} \quad h = \frac{400}{mg}$$

$$= \frac{400}{2 \times 10}$$

$$= 20\ \text{m.}$$

Example 7 A body performs 100 J in 5 seconds. What is its power?

Solution

$$\text{Power} = \frac{\text{Work}}{\text{Time}}$$

$$= \frac{100\ \text{J}}{5\ \text{s}}$$

$$= 20\ \frac{\text{J}}{\text{s}}$$

$$= 20\ \text{W.}$$

Example 8 An engine supplies 6000 joules of energy per minute. Find the power supplied by the engine in kilowatt.

Solution Given:

Work done, $W = 6000$ J

Time, $t = 1$ minute

$= 60$ s

$$\text{Power} = \frac{\text{Work}}{\text{Time}}$$

$$= \frac{6000\ \text{J}}{60\ \text{s}}$$

$$= 100\ \text{W}$$

$$= 0.1\ \text{kW}.$$

Example 9 An engine burns 1 g fuel oil to provide 36 kilojoule of energy. How much fuel oil will be required to get 1 kWh energy?

Solution

$$1\ \text{kWh} = 3.6 \times 10^6\ \text{J}$$

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

$$= 1 \times \left(\frac{3.6 \times 10^6}{36 \times 10^3}\right)$$

$$= 100\ \text{g}$$

$$= 0.1\ \text{kg}.$$

Example 10 1 g of coal on complete combustion liberates 350 kJ of energy. Calculate the power of a hearth in kW units in which 100 g of coal burns per second.

Solution

1 g of coal liberates energy = 350 kJ

100 g of coal liberates energy = (350×100) kJ

$= 35000$ kJ

As 100 g of coal burns per second, energy liberated per second $= 35000\ \text{kJ s}^{-1}$

$= 35000$ kW

Thus, the power of the hearth = 35000 kW.

Example 11 A machine lifts 40 kg to a height of 5 m in 4 min. What is the power of the machine? Take $g = 10\ \text{ms}^{-2}$.

Solution Given:

$m = 40$ kg

$h = 5$ m

$g = 10\ \text{ms}^{-2}$

time, $t = 4$ min

$= 4 \times 60 = 240$ s

work done or energy supplied

$= mgh$

$= 40 \times 10 \times 5$

$= 2000$ J

$$\text{Power} = \frac{\text{Energy supplied}}{\text{Time taken}}$$

$$= \frac{2000\ \text{J}}{240\ \text{s}} = 8.33\ \text{W}.$$

Example 12 Water is falling on the blades of a turbine at the rate of 6×10^3 kg per minute. The height of the fall is 10 m. Calculate the power given to the turbine. Take $g = 10\ \text{ms}^{-2}$.

Solution Given:

Mass of water falling, $m = 6 \times 10^3$ kg

$h = 10$ m

$g = 10\ \text{ms}^{-2}$

$t = 60$ s

Potential energy of falling water is equal to the kinetic energy imparted to turbine, and is equal to the work done (W) $= mgh$

$= 6 \times 10^3 \times 10 \times 10$

$= 6 \times 10^5$ J

$\therefore$ Power given to the turbine, $P = \frac{\text{W}}{\text{t}}$

$$= \frac{6 \times 10^5\ \text{J}}{60\ \text{s}}$$

$$= 10^4\ \text{W}$$

$$= 10\ \text{kW}.$$

Example 13 The heat liberated on complete burning of 0.175 g of kerosene raises the temperature of 350 g of water by 5°C. What is the calorific value of kerosene if the specific heat of water is 4.18 J/g°C.

Solution Given:

Mass of water, $m = 350$ g

Specific heat, $S = 4.18$ J/g °C

Mass of fuel, i.e., kerosene used = 0.175 g

Rise in temperature, $\theta = 5°C$

Heat gained by water = $mS\theta$

$= 350 \times 4.18 \times 5$

$= 7315$ J

We are given, 0.175 g of kerosene gives out 7315 J of heat energy.

Thus, 1 g of kerosene will give = $\frac{7315}{0.175}$

$= 41800$ J

In other words, the calorific value of kerosene (by definition) is 41800 J/g or 41.8 kJ/g.

Example 14 The surface area of a concentrator type solar cooker heater is 5 m^2. It can reflect 80% of the solar radiation incident on it while it absorbs the rest. Find the energy concentrated by the heater at its focus in 2 hours if solar energy were delivered to it at the rate of 0.4 $kJm^{-2}s^{-1}$.

Solution

Rate at which heat delivered = 0.4 $kJm^{-2}s^{-1}$

Time = 2 hours = $2 \times 60 \times 60 = 7200$ s

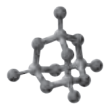
Surface area = 5 m^2

Solar radiation concentrated by the cooker

= 20% of solar radiation incident = $\frac{20}{100} \times 0.4$

= 0.08 $kJm^{-2}s^{-1}$.

Total energy concentrated by the heater in 2 hours, $Q = 0.08 \times 5 \times 7200 = 2880$ kJ.



UNSOLVED NUMERICAL PROBLEMS

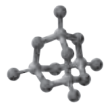
Level I (Elementary)

1. One gram of kerosene on burning provides 48 kJ of energy. How much kerosene would you need to provide energy equivalent to 50 kWh? (**Ans.** 3.75 kg)
2. A family consumes 14 kg kerosene in 30 days. What is the average energy consumed per day, if the calorific value of kerosene is 48 kJ g^{-1}? (**Ans.** 22400 kJ)
3. Calculate the energy possessed by a stone of mass 10 g kept at a height of 5 m. Take g = 9.8 ms^{-2}. (**Ans.** 0.49 J)
4. A moving body of mass 10 kg has 20 J of kinetic energy. Calculate its speed. (**Ans.** 2 ms^{-1})
5. Find the rise in temperature of a copper vessel of mass 200 g, when 1600 calorie of heat is supplied to it. Specific heat of cooper = 420 J kg^{-1} $°C^{-1}$. (**Ans.** 80°C)
6. One gram of coal on complete combustion liberates 350 kJ energy. Calculate the power of the furnace is kW is which 100 g of coal burns in one second. (**Ans.** 35000 kW)
7. A man weighing 100 kg and running on a track wants to increase his speed from 8 ms^{-1} to 10 ms^{-1}. Find the minimum time in which he can do this if the maximum power is 900 W. (**Ans.** 1.2 s)

Level II (Conceptual)

1. An athlete weighing 70 kg runs up a staircase, raising himself vertically 10 m in 35 seconds. If g = 10 ms^{-2}, calculate the power of the athlete. (**Ans.** 0.2 kW)
2. The work done by the heart for each heat is 1 joule. Calculate the power of the heart if it beats 72 times in a minute. (**Ans.** 1.2 W)
3. A 200 W bulb is lighted for two hours. How much energy is consumed? (**Ans.** 1.44×10^6 J)
4. A child climbs 10 stairs in 10 seconds. The child has a mass of 25 kg and each stair is 25 cm high. Calculate the power delivered by the child in overcoming the gravitational pull of the earth. (**Ans.** 62.5 W)
5. The lungs perform 2.4 J of work during each expansion. How many times per minute do they expand if their power is 2 W? (**Ans.** 50)
6. A machine does 1960 joules of work in 240 seconds. What is the power of the machine? (**Ans.** 8.17 W)

7. The entire 8400 J energy is converted into heat to raise the temperature of 1 kg of water. What will be the rise in temperature? The specific heat of water is 4200 J kg^{-1} $°C^{-1}$. (**Ans.** 2°C)
8. The calorific value of a gas is 55 kJ g^{-1}. If a furnace consumes 50 g gas in 100 seconds, calculate the power of furnace. (**Ans.** 27.5 kW)
9. A burner produces 90 kJ heat is one and half minute, when 1 g of fuel burns is it. Calculate the power of consumption of burner in kilowatt. (**Ans.** 1 kW)



OBJECTIVE EVALUATION

I. Objective Questions

1. Match the items of column I with their corresponding items of column II.

Column I	Column II
1. Most abundant fuel on earth	(a) cluster of windmills
2. Fermentation of biomass produces	(b) CNG
3. Wind energy farm	(c) Hydrogen
4. Largest component of biogas	(d) Solar energy
5. Gas used in transport vehicles	(e) LPG
6. Fuel having the largest calorific fuel	(f) methane
7. Gas used for cooking	(g) natural gas
8. Source of wind energy	(h) ethanol

Ans. 1. (g) 2. (h) 3. (a)
4. (f) 5. (b) 6. (c)
7. (e) 8. (d)

2. Which of the following energies is not ultimately derived from the sun?
(a) Biomass energy
(b) Hydro energy
(c) Geothermal energy
(d) Fossil fuel energy

Ans. (c)

3. The fuel for future is:
(a) gasohol (b) petrol
(c) hydrogen (d) CNG

Ans. (c) Latest technologies are being developed to overcome difficulties in the way of employing hydrogen as a fuel. Once we are able to achieve this, hydrogen will be among the best fuels available to us.

4. SI unit of solar constant is
(a) joule
(b) joule per $metre^2$
(c) watt per $metre^2$
(d) watt per $metre^3$

Ans. (c) Solar constant $(s) = \frac{\text{Solar energy}}{\text{Area} \times \text{time}}$

5. Which among the following is a non-conventional source of energy?

Ans. (a) Wind energy
(b) Ocean energy
(c) Hydro energy
(d) Coal

Ans. (b) Wind energy, hydro energy and coal are being used since long.

6. Which one of the following is a renewable source of energy?
(a) Natural gas (b) Hydrogen
(c) Oil (d) Coal

Ans. (b)

7. Though charcoal is a better fuel than wood and coal, it cannot be used to meet large scale requirements because:
(a) it causes pollution
(b) its calorific value is very small
(c) it cannot be easily stored
(d) it is quite expensive

Ans. (d) It is quite expensive because it is obtained by destructive distillation of wood.

8. If the solar energy received in 10 minutes by 10 m^2 area is 8400 kJ, the value of solar constant is

(a) 1.8 kW m^{-2} (b) 1.4 kW m^{-2}
(c) 3.6 kW m^{-2} (d) none of these

Ans. (b) Solar constant

$$= \frac{\text{Amount of solar energy received}}{\text{area} \times \text{time}}$$

$$= \frac{8400\,\text{kJ}}{10 \times 10 \times 60} = 1.4 \text{ kW m}^{-2}$$

9. A solar cell directly converts solar energy into

(a) chemical energy (b) heat energy
(c) electricity (dc) (d) electricity (ac)

Ans. (c)

10. The solar energy stored in the seas is in the form of heat is

(a) tidal energy (b) wind energy
(c) wave energy (d) OTE

Ans. (d)

11. The minimum wind velocity for a windmill to function is

(a) 15 m/s (b) 15 km/s
(c) 15 km/h (d) none of these

Ans. (b)

12. Acid rain happens because:

(a) Earth's atmosphere contains acids
(b) Sun leads to heating of upper layer of atmosphere
(c) burning of fossil fuels releases oxides of nitrogen, carbon and sulphur in the atmosphere
(d) none of these

Ans. (c) The oxides of carbon, nitrogen and sulphur react with water to produce acid rain

13. The main constituent of biogas is:

(a) hydrogen (b) carbon dioxide
(c) methane (d) hydrogen sulphide

Ans. (c)

14. Which part of the solar cooker is responsible for greenhouse effect?

(a) Glass sheet
(b) Mirror
(c) Coating with black colour inside the box
(d) Outer cover of the solar cooker

Ans. (a)

15. Fuel used in thermal power plants is:

(a) water (b) uranium
(c) biomass (d) fossil fuels

Ans. (d) In thermal power plants, coal and petroleum (fossil fuels) are used.

16. Which among the following is the ultimate source of energy?

(a) Uranium (b) Water
(c) Sun (d) Fossil fuels

Ans. (c)

II. True or False

State whether the following statements are true or false:

1. Solar energy is a non-renewable source of energy.
2. The renewable sources of energy are also called non-conventional sources of energy.
3. Petroleum and uranium are renewable sources of energy.
4. The non-renewable sources of energy are also called conventional sources of energy.
5. The efficiency of solar heating devices is much lower than the efficiency of electric heating devices.
6. Energy is a scalar physical quantity.
7. One calorie is much bigger than one joule.
8. 1 kWh = 3.6×10^5 joules.
9. The solar energy is always available uniformly all the time and at all places.
10. The excessive use of solar energy will pollute the air.
11. The reflector used in a solar cooker increases its efficiency.
12. Flowing water possesses thermal energy.
13. A simple machine can do more work in a lesser time.
14. Work and energy have different SI units.

15. The semi-conductors used in solar cells have very low electrical conductivity.
16. Coal gas is an example of primary fuel.
17. Wood contains more moisture and volatile impurities than charcoal.
18. Respiration is a slow combustion process.
19. The innermost zone of the candle flame is least hot.
20. A combustible substance serves as the fuel for fire.

Answers

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

III. Fill in the blanks

Fill in the blanks using suitable word(s):

1. kWh is the unit of _____.
2. A compressed spring has _____ energy.
3. The SI unit of energy is _____.
4. 1 calorie = _____ joule.
5. The rate of doing work is called _____.
6. Moving air is called _____.
7. Flowing water possesses _____.
8. The device used for obtaining energy from flowing water is called _____.
9. Energy is the ability to do _____.
10. The energy of a body is numerically equal to the amount of _____ which it can do.
11. At a thermal power station, the chemical energy of coal is changed into _____ energy, which is further changed into _____ energy.
12. The changing of one form of energy into another form of energy is called _____ of energy.
13. A steam engine converts the heat energy of steam into _____ energy.
14. Solar cells directly convert _____ energy into _____ energy.
15. The energy of _____ is called hydro energy.
16. Crude petroleum oil is refined by the process known as _____.
17. _____ is the best fuel in terms of energy liberated per gram of fuel.
18. Coal gas is a mixture of _____, _____ and _____.
19. Coal, petroleum and _____ are the three important sources of modern fuels.
20. The fuels which are prepared from natural fuels by various physical and chemical processes are known as _____.

Answers

1. energy	2. potential	3. joule
4. 4.2	5. power	6. wind
7. kinetic energy	8. water-wheel	
9. work	10. work	
11. heat, electrical	12. transformation	
13. mechanical	14. solar, electrical	
15. water	16. fractional distillation	
17. Hydrogen	18. H_2, CH_4 and CO	
19. natural gas		
20. manufactured or processed fuels		

IV. Multiple Choice Questions

Tick (✓) the only correct choice amongst the following:

1. A steam engine converts the heat energy of steam into
   (a) electrical energy
   (b) nuclear energy
   (c) mechanical energy
   (d) none of these
2. A motor converts electrical energy into
   (a) mechanical energy
   (b) chemical energy
   (c) nuclear energy
   (d) thermal energy
3. A battery converts chemical energy into
   (a) mechanical energy
   (b) solar energy

(c) electrical energy
(d) none of these

4. The ratio of SI units to CGS units of energy is
   (a) 10^5 (b) 10^6
   (c) 10^7 (d) 10^{-7}
5. Energy possessed by a body due to its motion is
   (a) kinetic energy
   (b) nuclear energy
   (c) potential energy
   (d) thermal energy
6. Energy possessed by a body due to its configuration is
   (a) kinetic energy
   (b) nuclear energy
   (c) potential energy
   (d) thermal energy
7. One erg is equal to
   (a) 1 g cm s^{-2} (b) 1 Nm
   (c) 10^7 J (d) 10^{-7} J
8. Which of the following is different from the others?
   (a) joule (b) kilowatt hour
   (c) erg (d) watt
9. If the product of muscle and speed equals power, what does muscle stand for?
   (a) Force (b) Power
   (c) Energy (d) Momentum
10. The product of force and displacement equals
    (a) work (b) power
    (c) momentum (d) none of these
11. The unit kWh represents
    (a) power (b) momentum
    (c) energy (d) force
12. Which of the following is the biggest unit of energy?
    (a) joule (b) kilowatt hour
    (c) erg (d) electron volt
13. One kWh is equal to
    (a) 3.6×10^6 J (b) 3.6×10^5 J
    (c) 3.6×10^4 J (d) 3.6×10^3 J
14. If the speed of a motor car becomes six times, then the kinetic energy becomes
    (a) 6 times (b) 36 times
    (c) 12 times (d) 24 times
15. The spring of the winding knob of a watch has
    (a) mechanical energy
    (b) only kinetic energy
    (c) only potential energy
    (d) kinetic or potential energy
16. A body is moved through a distance of 5 m in the following different ways. Maximum work is done when the body is
    (a) pushed over an inclined plane
    (b) raised vertically upwards
    (c) pushed over smooth rollers
    (d) pushed on a plane horizontal surface
17. In the above problem, minimum work is done when the body is
    (a) pushed over an inclined plane
    (b) raised vertically upwards
    (c) pushed over smooth rollers
    (d) pushed on a plane horizontal surface
18. A truck and a car are moving on a smooth, level road such that the kinetic energy associated with them is same. Brakes are applied simultaneously in both of them such that equal retarding forces are produced in them. Which one will cover a greater distance before it stops?
    (a) Car
    (b) Truck
    (c) Both will cover the same distance
    (d) Nothing can be decided
19. The unit kg m^2s^{-2} is associated with
    (a) work (b) kinetic energy
    (c) potential energy (d) all of the above
20. The kinetic energy of a body is increased most by doubling its
    (a) mass (b) density
    (c) weight (d) speed
21. A body is dropped from a certain height to the ground. When it is halfway down, it possesses

(a) only kinetic energy
(b) only potential energy
(c) both kinetic energy and potential energy
(d) neither kinetic energy nor potential energy

22. Asha lifts a doll from the floor and places it on a table. If the weight of the doll is known, what else does one need to know in order to calculate the work Asha has done on the doll?
(a) The time required
(b) Height of the table
(c) Mass of the doll
(d) Cost of the doll

23. One kilowatt approximately equals
(a) 1.30 hp (b) 2.50 hp
(c) 1.56 hp (d) 1.83 hp

24. The work done in lifting 1 kg mass to a height of 9.8 m is about
(a) 1 J (b) 9.8 J
(c) $(9.8)^2$ J (d) $\frac{1}{(9.8)^2}$ J

25. In which of the following case (see Fig. 6.5) will the work done be maximum when the body moves a distance *S* on the ground under the application of force *F* ?

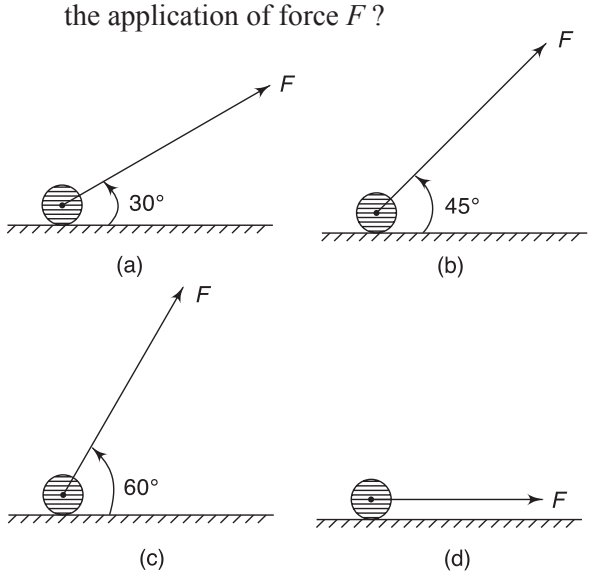


Fig. 6.5

26. Two bodies of equal weights are kept at heights *h* and 1.5*h* respectively. The ratio of their potential energies is
(a) 3 : 2 (b) 1 : 1
(c) 2 : 3 (d) 3 : 4

27. The acceleration due to gravity on the moon is one-sixth that on the earth. A high jumper can jump 2 m on earth. What distance can he jump on the moon?
(a) 2 m (b) 12 m
(c) 6 m (d) 8 m

28. Solar energy can be used to produce
(a) electrical energy
(b) mechanical energy
(c) heat energy
(d) all of the above

29. Which of the following devices transforms light energy into chemical energy?
(a) Car dynamo (b) Electric motor
(c) Electric fan (d) none of these

30. The momentum of a body increases by 20%. Then the percentage increase in its kinetic energy is
(a) 36 (b) 44
(c) 52 (d) 60

31. The energy of electric current is
(a) thermal (b) nuclear
(c) electrical (d) chemical

32. A simple machine is used to do
(a) less work
(b) more work
(c) work more conveniently
(d) work less conveniently

33. Which of the following does not represent a simple machine?
(a) Lever (b) Pulley
(c) Gear (d) Steam engine

34. The energy possessed by wind is
(a) kinetic energy (b) potential energy
(c) thermal energy (d) sound energy

35. Hydro-electric power generates
(a) electrical energy (b) nuclear energy
(c) thermal energy (d) none of these
36. The steam engine was invented by
(a) James Watt (b) Joule
(c) Newcommen (d) Newton
37. The fuel used in a steam engine is
(a) water
(b) carbon dioxide
(c) carbon monoxide
(d) none of these
38. The petrol engine was invented by
(a) Nikolaus Otto (b) James Watt
(c) Rudolph Diesel (d) none of these
39. Joule's experiment converts
(a) work into heat
(b) work into electricity
(c) heat into work
(d) electricity into work
40. One watt hour equals
(a) 3600 J (b) 360 J
(c) 36 J (d) 3.6 J
41. The term 'therm' is associated with
(a) heat (b) light
(c) magnetism (d) electricity
42. The efficiency of a heat engine can never be
(a) 10% (b) 20%
(c) 40% (d) 100%
43. A solar cell converts heat and light energy into
(a) heat energy (b) sound energy
(c) electricity (d) nuclear energy
44. One mega joule approximately equals
(a) 240 kcal (b) 2400 kcal
(c) 24 kcal (d) 2.4 kcal
45. A thermometer is used to measure
(a) heat
(b) thermal capacity
(c) water equivalent
(d) temperature
46. Heat flows as a result of difference in
(a) masses (b) weights
(c) temperatures (d) none of these
47. The temperature of water at the bottom of a waterfall is higher than that of the water at the top, because
(a) falling water absorbs heat from the sun
(b) kinetic energy of the falling water is converted into heat
(c) water at the bottom has greater potential energy
(d) the rocks on the river bed give out heat
48. Work done can be converted from joules to calories by
(a) dividing by J
(b) subtracting J
(c) multiplying by J
(d) adding J
where J is the mechanical equivalent of heat.
49. A car engine is an example of
(a) internal combustion engine
(b) external combustion engine
(c) neither internal nor external combustion engine
(d) both internal and external combustion engine
50. The practical unit for the measurement of electric power is
(a) watt (b) kilowatt
(c) kilowatt hour (d) horse power
51. Wood is a
(a) primary fuel (b) liquid fuel
(c) processed fuel (d) secondary fuel
52. An example of secondary fuel is
(a) coal (b) water gas
(c) natural gas (d) petroleum
53. Which of the following is an example of fossil fuel?
(a) Coal gas (b) Coke
(c) Natural gas (d) Producer gas
54. Most of the fuels are
(a) carbon compounds with sulphur
(b) nitrogen compounds with carbon

(c) carbon compounds with hydrogen
(d) none of these

55. Destructive distillation of coal leads to the formation of
(a) wood
(b) kerosene
(c) ammoniacal liquor
(d) charcoal

56. When steam is passed over hot coke, it produces
(a) producer gas (b) water gas
(c) laughing gas (d) coal gas

57. Producer gas is a mixture of
(a) carbon monoxide and nitrogen gas
(b) carbon monoxide and hydrogen gas
(c) carbon monoxide and water vapour
(d) carbon monoxide and nitrous oxide

58. The fractional distillation of coaltar yields
(a) carbon disulphide
(b) carbon tetrachloride
(c) kerosene oil
(d) benzene

59. Which of the following is not obtained on fractional distillation of petroleum?
(a) Paraffin wax (b) Asphalt
(c) Coal gas (d) Petroleum gas

60. Which of the following is formed under the earth by the decomposition of plant matter by anaerobic bacteria lying under water?
(a) Coal gas (b) Petroleum gas
(c) Natural gas (d) Producer gas

61. Which of the following is not used as a rocket fuel?
(a) Synthetic rubber (b) Liquid hydrogen
(c) Paraffin (d) Liquid nitrogen

62. Which of the following compound has a least heating value?
(a) Alcohol (b) Biogas
(c) Wood (d) Coal

63. The calorific value of methane in the following reaction is about
$2CH_4 + 4O_2 \rightarrow 2CO_2 + 4H_2O + 1780$ kJ
(a) 55 kJ/g (b) 110 kJ/g
(c) 110 J/g (d) 55 J/g

64. In *chulhas,* gaps are left between the logs
(a) to decrease the ignition temperature of the fuel
(b) to allow the air to enter and facilitate fuel burning
(c) to cut off the supply of air
(d) all of these

65. Kerosene burns more rapidly than coke because
(a) it has got more oxygen in it than coke
(b) it is a liquid hydrocarbon
(c) it has a low ignition temperature
(d) none of these

66. Which of the following is not an example of spontaneous combustion?
(a) Burning of liquified petroleum gas
(b) Fire caused in coal mines
(c) Dry white phosphorous liberates white fumes on exposure to air
(d) All of the above

67. Which of the following flames is produced by a candle?
(a) Blue flame
(b) Non-luminous flame
(c) Light giving flame
(d) Yellow luminous flame

68. Unburnt carbon particles are present in the
(a) blue zone
(b) dark inner zone
(c) luminous zone
(d) non-luminous zone

69. Which of the following is a supporter of combustion?
(a) Cooking gas (b) Nitrogen gas
(c) Oxygen gas (d) Producer gas

70. Biogas is a mixture of
(a) $CO + H_2 + CH_4$
(b) $CO_2 + CH_4 + H_2 + H_2S$
(c) $CO + H_2$
(d) $CO_2 + N_2$

71. Which of the following is non-renewable source of energy?
(a) Coal (b) Gobar gas
(c) Solar energy (d) Tidal energy

72. Which of the following is renewable source of energy?
(a) Wood (b) Petroleum
(c) Natural gas (d) Uranium

73. The sources of energy which are being produced continuously in nature and are inexhaustible, are called
(a) conventional sources
(b) non-renewable sources
(c) non-conventional sources
(d) none of these

74. Choose the source of energy which is different from others.
(a) Wood (b) Falling water
(c) Wind (d) Petroleum

75. Choose the source of energy which is different from others.
(a) Gobar gas (b) Vegetable refuse
(c) Plants (d) Crude oil

76. Choose the source of energy which is different from others.
(a) Natural gas (b) Petroleum
(c) Uranium (d) Wood

77. Choose the source of energy which is different from others.
(a) Lignite (b) Natural gas
(c) Sun (d) Coal

78. The difference in the concentration of salts in water of two different seas is called
(a) ocean current (b) nuclear fission
(c) oceanography (d) salinity gradient

79. The energy available due to the difference in the temperature of water at the surface of the ocean and at deeper levels is called
(a) tidal energy (b) wind energy
(c) solar energy (d) none of these

80. The vast amount of sea weeds present in oceans may provide an endless source of
(a) nuclear energy
(b) methane
(c) thermal energy ocean
(d) none of these

81. The energy of water is called
(a) mechanical energy
(b) hydroenergy
(c) solar energy
(d) none of these

82. The generation of electricity from water energy
(a) will never get exhausted
(b) will not produce any environmental pollution
(c) is renewable source of energy
(d) all the above are correct

83. Energy available from the oceans is
(a) OTE
(b) tidal energy
(c) sea-waves energy
(d) all of the above

84. Which of the following is not a form of oceanic energy?
(a) Energy from biomass
(b) Tidal energy
(c) Ocean thermal energy
(d) Solar energy

85. At many places in the ocean, the difference in temperatures between the water 'at the surface of ocean' and 'at deeper levels' is up to
(a) 120°C (b) 80°C
(c) 50°C (d) 20°C

86. The oceans cover almost _____ % of the surface of earth with water and act as a vast collector of _____ energy.
(a) 71, chemical (b) 97, solar
(c) 71, solar (d) 17, hydro energy

87. At present, the contribution of hydroelectricity to the total power generation in India is
(a) a little more than 23%
(b) a little more than 35%
(c) a little more than 47%
(d) none of these

88. Which of the following is not a high wind-energy region of India?
(a) Bay of Bengal
(b) Gujarat
(c) The Arabian sea Islands
(d) Punjab

89. The wind-energy map gives information about the

(a) causes of wind
(b) amount of rainfall
(c) intensity of earth quake
(d) none of these

90. SI unit of calorific value of a fuel is
(a) J (b) $J\ kg^{-1}$
(c) kg (d) none of these

91. Out of the following, which fuel has the greatest calorific value?
(a) Petrol (b) Kerosene
(c) Biogas (d) Coke

92. Out of the following, which fuel has the least calorific value?
(a) Petrol (b) Kerosene
(c) Diesel (d) Coke

93. Which of the following fuel is different from others?
(a) Water gas (b) Coal gas
(c) Producer gas (d) Coke

94. Which of the following fuel is different from others?
(a) Diesel (b) Gasoline
(c) Alcohol (d) Lignite

95. Which of the following fuel is different from others?
(a) Charcoal (b) Lignite
(c) Coke (d) Alcohol

96. Which of the following converts light energy into electrical energy?
(a) Motor (b) Battery
(c) Solar cell (d) None of these

97. The first practical solar cell was made in the year
(a) 1947 (b) 1954
(c) 1960 (d) 1972

98. Which of the following can't be used to make a solar cell?
(a) Silicon (b) Platinum
(c) Gallium (d) Germanium

99. With the addition of impurities, the resistance of a semi-conductor
(a) increases
(b) decreases
(c) first decreases then increases
(d) first increases then decreases

100. The efficiency of the modern solar cells from selenium is up to
(a) 25% (b) 40%
(c) 65% (d) 80%

101. The box-type solar cooker cannot be used
(a) for frying and baking
(b) during night time
(c) during the cloudy days
(d) all the above are correct

102. The group of solar cells joined together in a definite pattern is called a
(a) battery (b) solar heater
(c) solar cooker (d) solar cell panel

103. Which of the following can be used to fabricate a solar cell?
(a) Platinum (b) Gold
(c) Silver (d) Selenium

104. Every hot object emits
(a) infrared rays (b) visible rays
(c) X-rays (d) all of the above

105. How much solar energy will be received by 1 square metre area in one hour, if the solar constant were 1.4 kW per square metre?
(a) 5.40 J (b) 50.40 J
(c) 504 kJ (d) 5040 kJ

106. Which of the following is not derived from fossil source of energy?
(a) Coal (b) Kerosene
(c) CNG (d) Cow dung cake

107. Which of the following is the non-renewable source of energy?
(a) River (b) Wind
(c) Coal (d) Biogas

108. Which of the following has the maximum heating capacity?
(a) Petrol (b) CNG
(c) LPG (d) Furnace oil

109. Which of the following is more environment friendly?
(a) Fission reactor
(b) Fusion reactor
(c) Both are equally environment friendly
(d) Nothing can be decided

110. Which of the following contributes minimum to environmental pollution?
   (a) Burning of firewood
   (b) Burning of coal
   (c) Burning of charcoal
   (d) nothing can be decided
111. Which of the following gas is not combustible?
   (a) Oxygen (b) Hydrogen
   (c) Butane (d) Methane
112. Which of the following petroleum product is not combustible?
   (a) Kerosene (b) Naphtha
   (c) Petrol (d) CNG
113. The basic mechanism of power generation in tidal generator is
   (a) steam generated to run turbines
   (b) gases generated to run turbines
   (c) energy of wind used to run turbines
   (d) kinetic energy of flowing water used to run turbines
114. A heap of wet wood is burnt. It produces lot of smoke and leaves a residue. This residue is called
   (a) fly ash (b) tar
   (c) producer gas (d) marsh gas
115. Fly ash is used to make
   (a) bricks (b) tar
   (c) stream (d) solar cells

Answers

1. (c)	2. (a)	3. (c)	4. (c)
5. (a)	6. (c)	7. (d)	8. (d)
9. (a)	10. (a)	11. (c)	12. (b)
13. (a)	14. (b)	15. (c)	16. (b)
17. (c)	18. (c)	19. (d)	20. (d)
21. (c)	22. (b)	23. (a)	24. (c)
25. (d)	26. (c)	27. (b)	28. (d)
29. (d)	30. (b)	31. (c)	32. (c)
33. (d)	34. (a)	35. (a)	36. (c)
37. (d)	38. (a)	39. (a)	40. (a)
41. (a)	42. (d)	43. (c)	44. (a)
45. (d)	46. (c)	47. (b)	48. (a)
49. (a)	50. (a)	51. (a)	52. (b)
53. (c)	54. (c)	55. (c)	56. (b)
57. (a)	58. (d)	59. (c)	60. (c)
61. (d)	62. (c)	63. (a)	64. (b)
65. (c)	66. (a)	67. (d)	68. (c)
69. (c)	70. (b)	71. (a)	72. (a)
73. (c)	74. (d)	75. (d)	76. (d)
77. (c)	78. (d)	79. (d)	80. (b)
81. (b)	82. (d)	83. (d)	84. (d)
85. (d)	86. (c)	87. (a)	88. (d)
89. (d)	90. (b)	91. (a)	92. (d)
93. (d)	94. (d)	95. (d)	96. (c)
97. (b)	98. (b)	99. (b)	100. (a)
101. (d)	102. (d)	103. (d)	104. (a)
105. (d)	106. (d)	107. (c)	108. (d)
109. (b)	110. (c)	111. (a)	112. (b)
113. (d)	114. (b)	115. (a)	

V. Fun Time

(A) Crossword Puzzle:

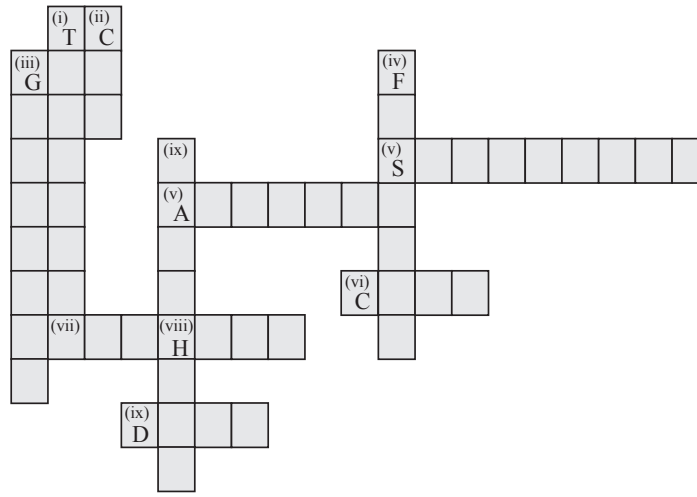
Read the clues given below and fill up the blocks with appropriate word/term to complete the crossword puzzle given below.

Down

(i) Its construction on River Ganga, was opposed.
(ii) Clean fuel (abbreviation).
(iii) Biogas is commonly called.
(iv) Nuclear power generation is based on this process.
(viii) This energy is converted into electrical energy in a thermal power plant.
(ix) Another name for methane.

Across

(v) It converts solar energy into electrical enery.
(vi) This fossil fuel made industrial revolution possible.
(vii) A greenhouse gas.
(ix) High rise structures constructed on rivers to produce hydroelectricity.



(B) Match Items of Column I with the Corresponding Items of Column II.

Column I	Column II
(a) Fossil Fuels	(i) does not create pollution
(b) Wood	(ii) methane
(c) Biogas	(iii) renewable source
(d) Hydroelectricity	(iv) non-renewable source
(e) Soloar energy	(v) used to propel sail boats
(f) Wind energy	(vi) gulf of Kutch in Gujarat
(g) Tidal energy	(vii) New Zealand and USA sea water by evaporation
(h) Geothermal energy	(viii) used to obtain salt from sea water by evaporation

(C) Word Puzzle

Read the clues given below and find out the appropriate words from the boxes.

Clues

(i) Dam whose construction on river Narmada was opposed.

(ii) Reactions in the interior of the sun.

(iii) The element can be used as a potential source of future.

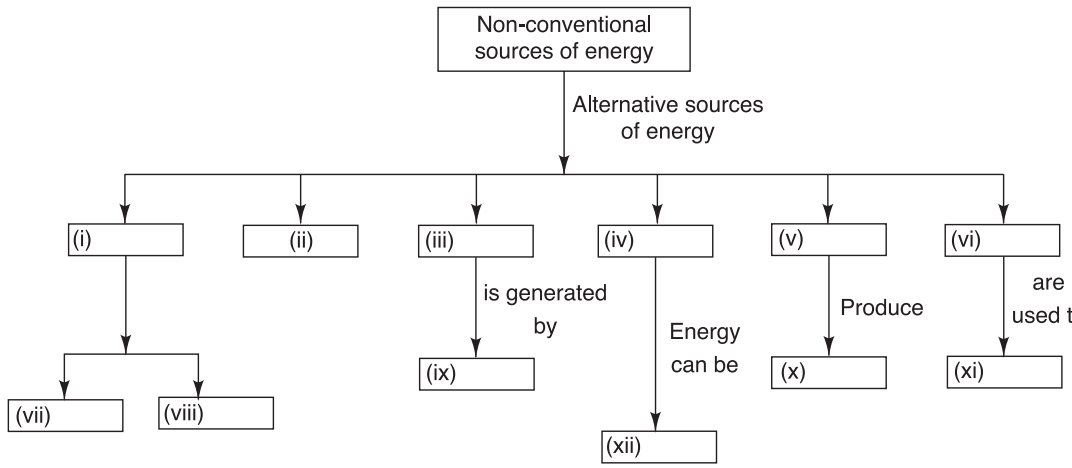
(iv) The principle is useful in solar cooker but its excess is harmful on earth.

(v) A device used to convert solar energy directily into electricity.

A	P	X	A	F	C	X	A	K	Z	A	O	X	Y	D	F
S	A	R	D	A	R	S	A	R	O	V	A	R	Z	E	G
H	R	A	C	G	D	Y	D	C	C	P	Q	R	S	T	U
I	M	Z	F	I	H	Y	D	R	O	G	E	N	N	O	P
J	N	X	U	J	R	Z	I	P	D	C	A	D	G	H	I
L	O	Y	S	O	L	A	R	C	E	L	L	J	K	M	N
M	S	P	I	K	Q	L	P	L	P	E	A	C	F	G	L
N	T	L	O	A	S	M	L	T	A	L	C	L	M	L	N
O	U	M	N	M	T	N	M	X	T	M	X	Y	K	M	S
G	R	E	E	N	H	O	U	S	E	E	F	F	E	C	T
C	V	S	D	N	U	S	S	Y	S	N	T	U	A	B	D

(D) Flow Chart Worksheet:

Complete the following flow chart:



(E) Crossword Puzzle:

Solve the crossword puzzle with the help of the hints that are provided below:

Down

(i) Substance having very low electrical conductivity.

(ii) The number of waves in one second.

(iii) The material contained in the bodies of plants and animals.

(iv) They remove the heat from the reaction chamber.

(v) Device used to reduce speed of the neutrons.

(vi) Used to get rid of moisture content in food grain.

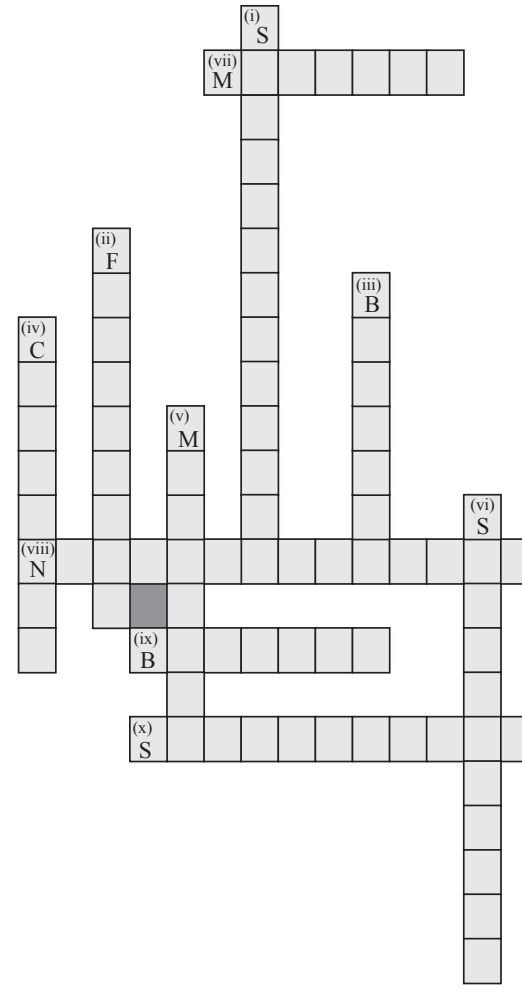
Across

(vii) The main constituent of biogas.

(viii) Splitting of heavy uranium into lighter nuclei of smaller atomic numbers.

(ix) The residue of sugarcane after extracting juice from them.

(x) The device which is used to cook food using solar energy.



Hints

(A) Down: (i) TEHRI DAM (ii) CNG (iii) GOBAR GAS (iv) FISSION (viii) HEAT (ix) MARSH GAS

Across: (v) SOLAR CELL (vi) COAL (vii) METHANE (ix) DAMS

(B) (a)—(iv) (b)—(iii) (c)—(ii) (d)—(i) (e)—(viii) (f)—(v) (g)—(vi) (h)—(vii)

(C) (i) SARDAR SORAVAR (ii) FUSION (iii) HYDROGEN (iv) GREENHOUSE EFFECT (v) SOLAR CELL

(D) (i) Fossil fuels (ii) Sea waves (iii) Hydro electricity (iv) wind (v) Infrared rays (vi) Ultraviolet rays (vii) Coal (viii) Petroleum (ix) Hydel energy (x) Heat (xi) kill germs (xii) regenerated

(E) Down: (i) SEMICONDUCTOR (ii) FREQUENCY (iii) BIOMASS (iv) COOLATNTS (v) MODERATOR

Across: (vii) METHANE (viii) NUCLEAR FISSION (ix) BAGGAGE (x) SOLAR COOKER