Chapter 6. Heat and Energy

Exercise 6(A)

Solution 1S.

Heat is the energy of random motion of molecules constituting the body.
Its S.I. unit is 'joule'.

Solution 2S.

Heat will flow from a hot body (body at a higher temperature) to a cold body (body at a lower temperature).

Solution 3S.

S.I. unit of heat is 'joule'.
1 joule = 0.24 cal

Solution 4S.

Temperature is the parameter which tells the thermal state of a body (i.e. the degree of hotness or coldness).
The S.I. unit of temperature is 'kelvin'.

Solution 5S.

On touching a piece of ice, heat flows from our hand (hot body) to the ice (cold body), and hence, it appears cold.

Solution 6S.

Heat is a form of energy obtained due to the random motion of molecules in a substance but temperature is a quantity which decided the direction of flow of heat when two bodies at different temperature are placed in contact. Two quantities having the same amount of heat may differ in temperature.

Solution 7S.

The expansion of a substance on heating is called thermal expansion.

Solution 8S.

Brass and iron expand on heating.

Solution 9S.

Water contracts on heating from 0°C to 4°C.

Silver iodide contracts on heating from 80°C to 141°C.

Solution 10S.

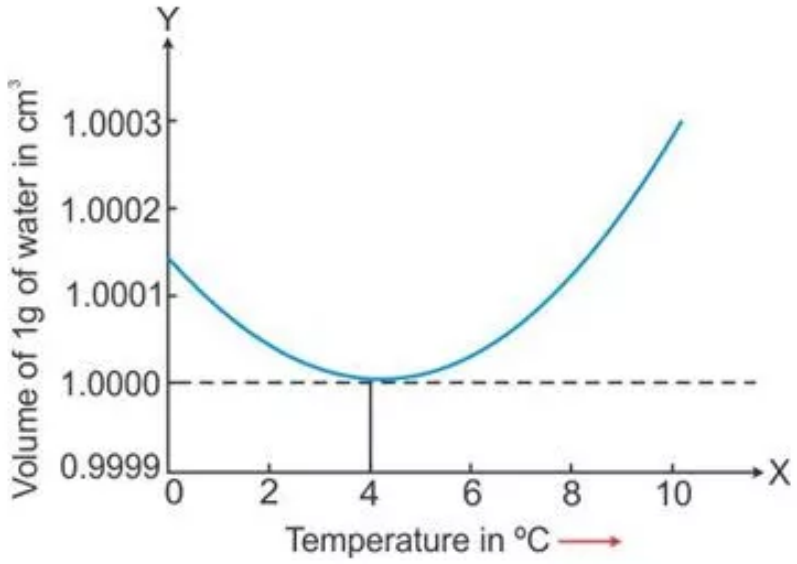
The expansion of water when it is cooled from 4°C to 0°C is known as the anomalous expansion of water.

Solution 11S.

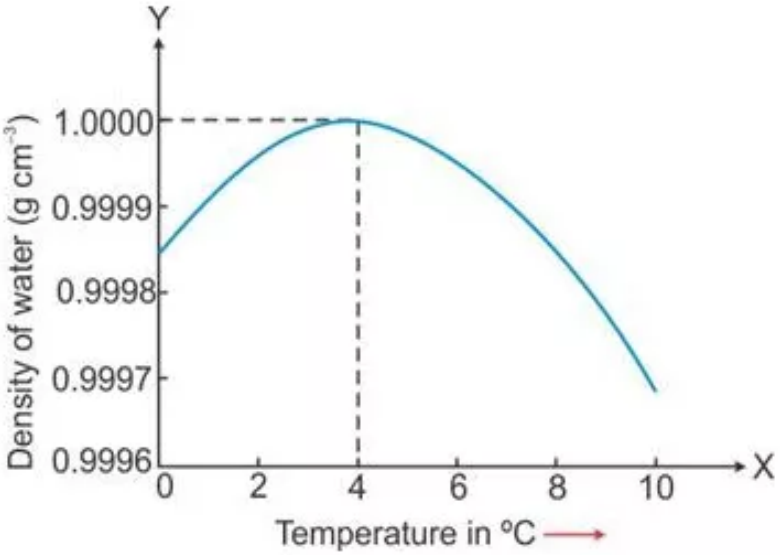
Density of water is maximum at 4°C. Its value is 1000 kgm^{-3}.

Solution 12S.

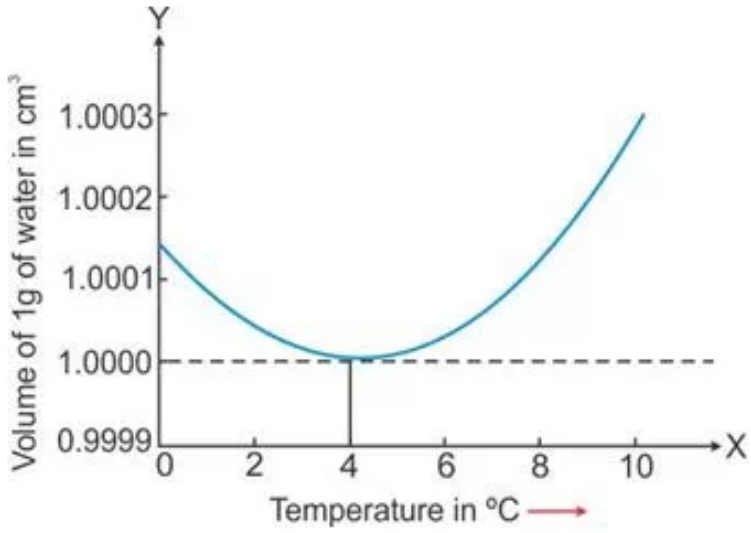
When a given mass of water is heated from 0°C to 4°C, it contracts, i.e. its volume decreases.
On heating from 4°C to 10°C, it expands, i.e. its volume increases.



Solution 13S.

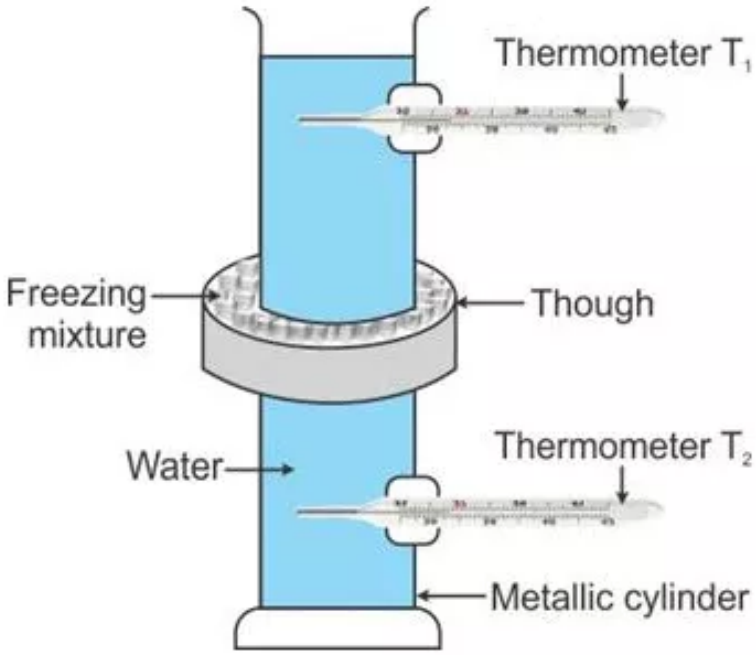


Solution 14S.



Solution 15S.

Hope's experiment to demonstrate that water has maximum density at 4°C:



Hope's apparatus consists of a tall metallic cylinder provided with two side openings P and Q, P near the top and Q near the bottom, fitted with thermometers T_1 and T_2 in them. The central part of the cylinder is surrounded with a cylindrical trough containing a freezing mixture of ice and salt. The cylinder is fitted with pure water at room temperature.

Observations: (i) Initially, both thermometers T_1 and T_2 are at the same temperature.

(ii) First, the temperature recorded by the lower thermometer T_2 starts decreasing and finally it becomes steady at 4°C, while the temperature recorded in the upper thermometer T_1 remains almost unchanged during this time.

(iii) Then, the temperature recorded by the lower thermometer T_2 remains constant at 4°C and upper thermometer T_1 records a continuous fall in temperature up to 0°C and then it becomes steady.

Thus, finally, the temperature recorded by the upper thermometer is 0°C and that by lower thermometer is 4°C.

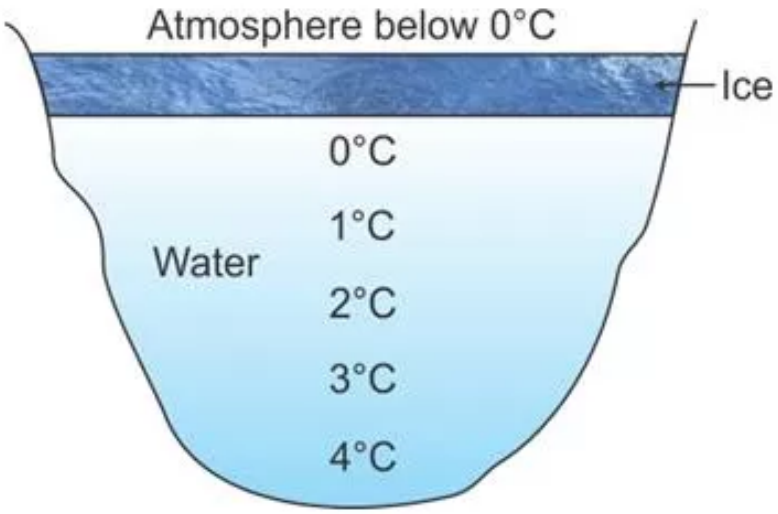
As the freezing mixture cools water in the central portion of the cylinder, water contracts and its density increases, consequently it sinks to the bottom, thereby causing the reading of the lower thermometer T_2 to fall rapidly. The reading of the upper thermometer T_1 does not change as the temperature of water in the upper part does not change. This continues till the entire water below the central portion reaches 4°C. On cooling further below 4°C, due to anomalous expansion, water of the central portion expands, so its density decreases and hence it rises up. As a result, reading of the upper thermometer T_1 falls rapidly to 0°C and water freezes to form ice at 0°C near the top. This proves that water has maximum density at 4°C.

This anomalous expansion of water helps in preserving the aquatic life during the very cold weather. In winters, when the temperature falls, the top layer of water in a pond contracts, becomes denser and sinks to the bottom. A circulation is thus set up until the entire water in the pond reaches its maximum density at 4°C. If the temperature falls further, then the top layer expands and remains on the top till it freezes. Thus, even though the upper layers are frozen, the water near the bottom is at 4°C and the fishes can survive in it easily.

Solution 16S.

(i) Water just in contact with ice is at 0°C.
(ii) Water at the bottom of the pond is at 4°C.

Solution 17S.



Solution 18S.

(a) On winter nights, as the atmospheric pressure starts falling below 4°C, water in the pipe lines expand and exert a great pressure on the pipes, causing them to burst.

(b) In winters, when temperature falls, the surface of water in the tank contracts, becomes denser and sinks to the bottom. A circulation is thus set up until the entire water in the tank reaches its maximum density at 4°C. If the temperature falls further, then the top layer expands and remains on the top till it freezes. Thus, water in a tank starts freezing from the top and not from the bottom.

(c) The anomalous expansion of water helps preserve aquatic life during very cold weather. When temperature falls, the top layer of water in a pond contracts becomes denser and sinks to the bottom. A circulation is thus set up until water in the pond reaches its maximum density at 4°C. If the temperature falls further, then the top layer expands and remains on the top till it freezes. Thus, even though the upper layer are frozen, the water near the bottom is at 4°C and the fishes can survive in it easily.

(d) On heating water above 4°C, the density of water decreases. As a result, the upthrust acting due to water on hollow glass sphere also decreases, which causes it to sink.

(e) Inside the freezer, when the temperature of water falls below 4°C, the water in the bottle starts expanding. If the bottle is completely filled and tightly closed, there is no space for water to expand, and hence, the bottle may burst.

Solution 1M.

Calorie is the unit heat.

Solution 2M.

1 calorie = 4.186 J
Therefore,
1 J = 1/4.186 = 0.24 cal

Solution 3M.

The SI unit of temperature is kelvin (K).

Solution 4M.

Water shows anomalous behavior between 0°C and 4°C. Hence, when it is cooled it expands.

Solution 5M.

Water shows anomalous behavior between 0°C and 4°C. It has lowest volume at 4°C. Hence, its density will be maximum at 4°C.

Exercise 6(B)

Solution 1S.

A unit composed of biotic components (i.e. producers, consumers and decomposers) and abiotic components (i.e. light, heat, rain, and humidity, inorganic and organic substances) is called an ecosystem.

Solution 2S.

The source of energy for all ecosystems is the Sun.

Solution 3S.

Green plants absorb most of the energy falling on them and by the process of photosynthesis they produce food for the consumers. Plants, being primary producers are of great importance in the ecosystem. They also maintain the balance of oxygen and carbon dioxide on earth.

Solution 4S.

Producers like plants and some bacteria are capable of producing its own food using the energy of sun but consumers are not capable of producing their own food. They depend on producers for food.

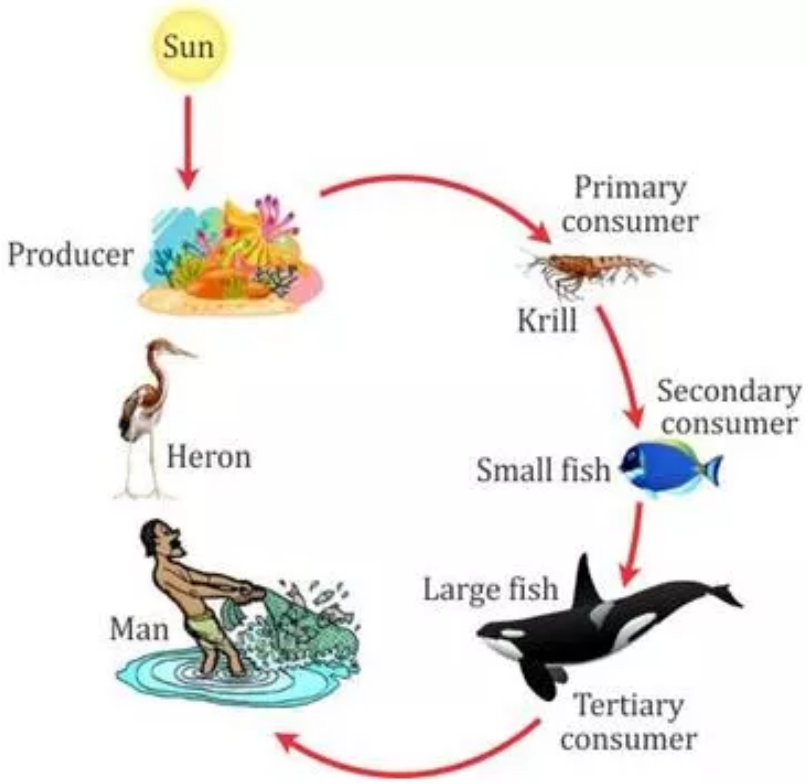
Solution 5S.

The role of a decomposer is to break down dead organisms and then feed on them. The nutrients created by the dead organisms are returned to the soil to be later used by the producers. Once these deceased organisms are returned to the soil, they are used as food by bacteria and fungi by transforming the complex organic materials into simpler nutrients. The simpler products can then be used by producers to restart the cycle. These decomposers play an important role in every ecosystem.

Solution 6S.

A food chain shows the feeding relationship between different living things in a particular environment or habitat. Often, a plant will begin a food chain because it can make its own food using energy from the Sun. In addition, a food chain represents a series of events in which food and energy are transferred from one organism in an ecosystem to another. Food chains show how energy is passed from the sun to producers, from producers to consumers, and from consumers to decomposers.

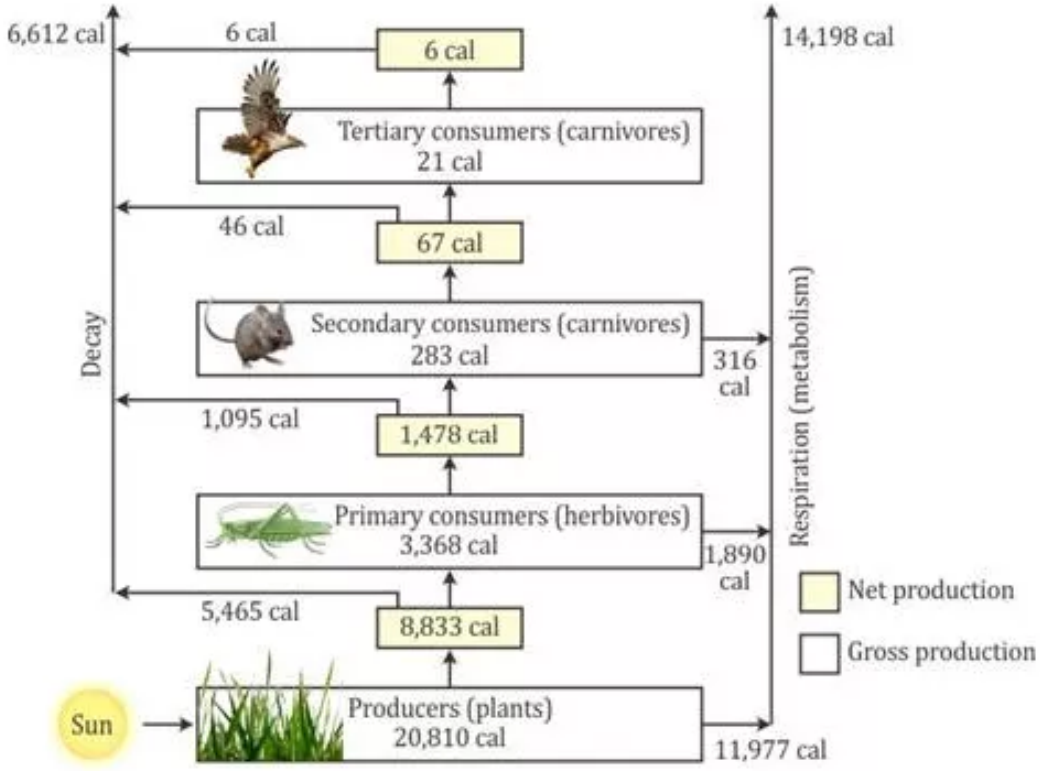
Solution 7S.



Solution 8S.

Ecosystems maintain themselves by cycling energy and nutrients obtained from external sources. At the first trophic level, primary producers (plants, algae, and some bacteria) use solar energy to produce organic plant material through photosynthesis. Herbivores-animals that feed solely on plants-make up the second trophic level. Predators that eat herbivores comprise the third trophic level; if larger predators are present, they represent still higher trophic levels. Decomposers, which include bacteria, fungi etc.

break down wastes and dead organisms and return nutrients to the soil.



On average about 10 percent of net energy production at one trophic level is passed on to the next level. Processes that reduce the energy transferred between trophic levels include respiration, growth and reproduction, defecation, and non-predatory death.

The low rate of energy transfer between trophic levels makes decomposers generally more important than producers in terms of energy flow. Decomposers process large amounts of organic material and return nutrients to the ecosystem in inorganic forms, which are then taken up again by primary producers.

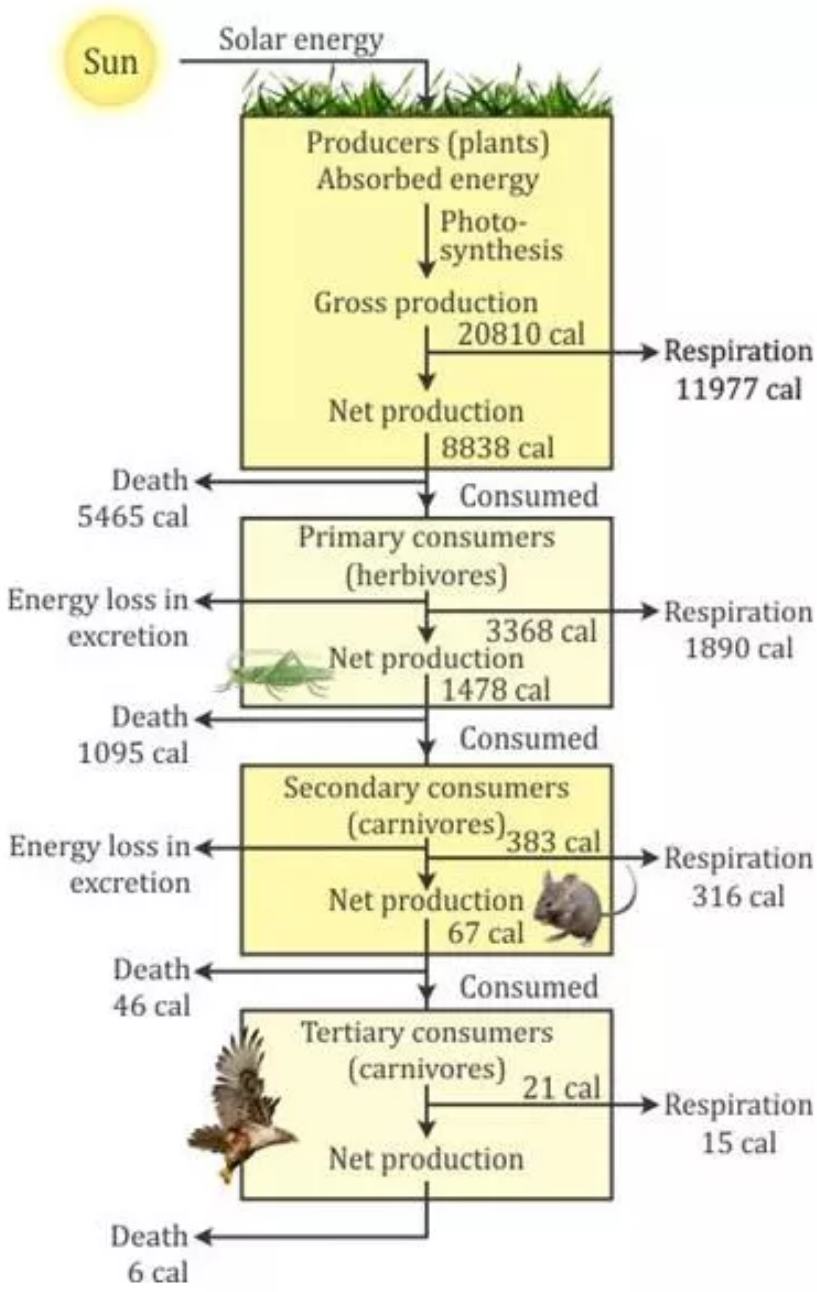
Solution 9S.

The laws of thermodynamics govern the energy flow in the ecosystem.
According to the first law of thermodynamic, the energy can be transformed from one form to the other form, but it can neither be created nor destroyed.
According to the second law of thermodynamics, when energy is put to work, a part of it is always converted in un-useful form such as heat mainly due to friction and radiation.

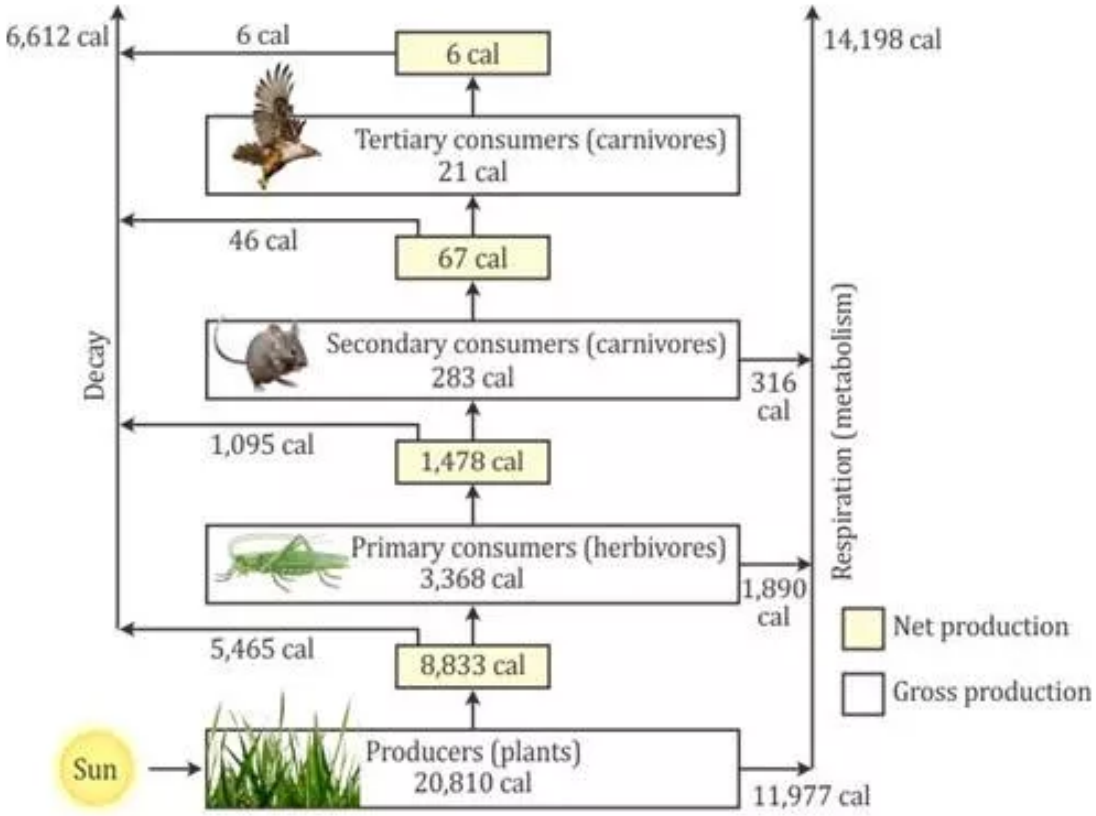
Solution 10S.

The energy flow in ecosystem is linear i.e., it moves in a fixed direction. The solar energy is absorbed by plants and a part of it is converted into food. These plants (or primary producers) are then eaten by the primary consumers, which are consumed by secondary consumers and the secondary by tertiary consumers. This cycle is unidirectional. The dead and decomposed are fed by decomposers, which return the nutrients to the soil. At the end, the energy reaches the degraded state. It does not return to the sun to make the process cyclic, thus energy flow is linear.

Solution 11S.



Solution 12S.



Solution 1M.

Photosynthesis

Solution 2M.

Sun

Solution 3M.

Producers

Solution 4M.

Consumer

Exercise 6(C)

Solution 1S.

1. A source of energy should be safe and convenient to use.
2. A source of energy should be economical and easy to store and transport.

Solution 2S.

The two groups in which various sources of energy are classified are renewable or non-conventional sources of energy and non-renewable or conventional sources of energy. These sources are classified on the basis of their availability and utility.

Solution 3S.

Renewable: The natural sources providing us energy continuously are called renewable sources of energy.
Non-renewable: The sources of energy which have accumulated in nature over a very long period of time and cannot be quickly replaced when exhausted are called non-renewable sources of energy.

Difference:

Renewable sources	Non-renewable sources
They can be utilised continuously.	They cannot be utilised once exhausted.
Examples: Sun, Wind	Example: Coal, Petroleum

Solution 4S.

Renewable: Wood, Water and Wind
Non-renewable: Coal, Diesel and Oil

Solution 5S.

Wood is obtained from trees. Hence, trees need to be cut down for wood to be used as a fuel.
Also, burning wood releases a lot of smoke which pollutes the atmosphere.

Solution 6S.

Renewable:

1. Sun
2. Wind
3. Flowing water
4. Tides
5. Nuclear fuel

Non-renewable:

1. Coal
2. Petroleum
3. Natural gas

Solution 7S.

1. **Tidal energy:** The energy possessed by rising and falling water in tides is known as tidal energy.Dams are constructed across a narrow opening to the sea to harness tidal energy and produce electricity. However, it is not a major source of energy as the rise and fall of seawater during tides is not enough to generate electricity on a large scale.
2. **Ocean energy:** Water in the oceans possesses energy in two forms:

1. **Ocean thermal energy-** The energy available due to the difference in temperature of water at the surface and at deeper levels of ocean is called the ocean thermal energy. This energy is harnessed for producing electricity by a device called ocean thermal energy conversion power plant (OCTEC power plant).
2. **Oceanic waves energy-** The kinetic energy possessed by fast moving oceanic (or sea) waves is called oceanic waves energy. Though models have been made to generate electricity from oceanic waves, but so far it has not been put to practical use.

3. **Geo thermal energy:** The heat energy possessed by the rocks inside the Earth is called geothermal energy.The hot rocks present at the hot spots deep inside the Earth, heat the underground water and turn it into steam. This steam is compressed at high pressure between the rocks. Holes are drilled deep into the Earth up to the hot spots to extract the steam through pipes, which is utilized to rotate the turbines connected to the armature of an electric generator to produce electricity.

Solution 8S.

Sun is the main source of energy on Earth.

Solution 9S.

The energy obtained from Sun is called solar energy.

A solar power plant is a device in which heat energy of sun is used to generate electricity. It consists of a large number of concave reflectors, at the focus of which there are black painted water pipes. The reflectors concentrate the heat energy of the sun rays on the pipes due to which water inside the pipes starts boiling and produces steam. The steam thus produced is used to rotate a steam turbine which drives a generator producing electricity.

Solution 10S.

A solar cell is an electrical device that converts light energy directly into electricity with the help of photovoltaic effect. Solar cells are usually made from semiconductors like silicon and gallium with some impurity added to it. When sunlight is made incident on a solar cell, a potential difference is produced between its surface, due to which a current flows in the circuit connected between the opposite faces of the semiconductor.

Two uses of solar cells are as listed below:

1. They do not require maintenance and last over a long period of time at zero running cost.
2. They are very useful for remote, inaccessible and isolated places where electric power lines cannot be laid.Solar cell produces d.c. (direct current).

One disadvantage of solar cell is listed below:

1. The initial cost of a solar panel is sufficiently high.

Solution 11S.

Advantages of using solar panels:

1. They do not cause any pollution in the environment.
2. Running cost of solar panel is almost zero.
3. They last over a long period of time.
4. They do not require any maintenance.
5. They are suitable for remote and inaccessible places where electricity power lines cannot be laid.

Disadvantages of using solar panels:

1. The initial cost of a solar panel is sufficiently high.
2. The efficiency of conversion of solar energy to electricity is low.
3. A solar panel produces d.c. electricity which cannot be directly used for many household purposes.

Solution 12S.

The kinetic energy of the moving large masses of air is called the wind energy. Wind energy is used in a wind generator to produce electricity by making use of wind mill to drive a wind generator.

At present in India, more than 1025 MW electric power is generated using wind energy.

Solution 13S.

Advantages of using wind energy:

1. It does not cause any kind of pollution.
2. It is an everlasting source.

Limitations of using wind energy:

1. The establishment of a wind farm is expensive.
2. A large area of land is needed for the establishment of a wind farm.

Solution 14S.

The kinetic energy possessed by flowing water is called the water or hydro energy. Principle of a hydroelectric power plant is that the water flowing in high altitude rivers is collected in a high dam (or reservoir). The water from the dam is then allowed to fall on a water turbine which is located near the bottom of the dam. The shaft of the turbine is connected to the armature of an electric generator or dynamo.

At present only 23% of the total electricity is generated by the hydro energy.

Solution 15S.

Advantages of producing the hydro electricity:

1. It does not produce any environmental pollution.
2. It is a renewable source of energy.

Disadvantages of producing hydroelectricity:

1. Due to the construction of dams over the rivers, plants and animals of that place get destroyed or killed.
2. The ecological balance in the downstream areas of rivers gets disturbed.

Solution 16S.

When a heavy nucleus is bombarded with slow neutrons, it splits into two nearly equal light nuclei with a release of tremendous amount of energy. In this process of nuclear fission, the total sum of masses of products is less than the total sum of masses of reactants. This lost mass gets converted into energy. The energy so released is called nuclear energy.

Principle: The heat energy released due to the controlled chain reaction of nuclear fission of uranium-235 in a nuclear reactor is absorbed by the coolant which then passes through the coils of a heat exchanger containing water. The water in heat exchanger gets heated and converts into steam. The steam is used to rotate the turbine which in turn rotates the armature of a generator in a magnetic field and thus produces electricity.

Solution 17S.

At present only about 3% of the total electrical power generated in India is obtained from the nuclear power plants.
Tarapur in Maharahtra and Narora in Uttar Pradesh are the places where electricity is produced using nuclear energy.

Solution 18S.

Advantages of using nuclear energy:

1. A very small amount of nuclear fuel can produce a tremendous amount of energy.
2. Once the nuclear fuel is loaded into nuclear power plant, it continues to release energy for several years.

Disadvantages of using nuclear energy:

1. It is not a clean source of energy because very harmful nuclear radiations are produced in the process.
2. The waste causes environmental pollution.

Solution 19S.

i. Light energy into electrical energy
ii. Mechanical energy into electrical energy.
iii. Mechanical energy into electrical energy.
iv. Nuclear energy (or heat energy) into electrical energy.

Solution 20S.

Four ways for the judicious use of energy are:

1. The fossil fuels such as coal, petroleum, natural gas should be used only for the limited purposes when there is no other alternative source of energy available.
2. The wastage of energy should be avoided.
3. Efforts must be made to make use of energy for community or group purposes.
4. The cutting of trees must be banned and more and more new trees must be roped to grow.

Solution 21S.

The gradual decrease of useful energy due to friction etc. is called the degradation of energy.
Examples:

1. When we cook food over fire, the major part of heat energy from the fuel is radiated out in the atmosphere. This radiated energy is of no use to us.
2. When electrical appliances are run by electricity, the major part of electrical energy is wasted in the form of heat energy.

Solution 22S.

The conversion of part of energy into a non-useful form of energy is called degradation of energy.

Solution 1M.

The ultimate source of energy is the Sun.

Solution 2M.

Renewable source of energy is the Sun.

Exercise 6(D)

Solution 1S.

Greenhouse effect is the process of warming of planet's surface and its lower atmosphere by absorbtion of infrared radiations of longer wavelength emitted out from the surface of planet.

Solution 2S.

Carbon-di-oxide, water vapour and methane are greenhouse gases.

Solution 3S.

Visible light rays and short infrared radiation pass through the atmosphere of earth.

Solution 4S.

Infrared radiations of long wavelength are absorbed by the green house gases.

Solution 5S.

The concentration of carbon-di-oxide content's of earth's atmosphere has increased due to industrial growth, combustion of fossil fuels and clearing of forests.

Solution 6S.

In absence of green house gases, the average temperature on earth would be -18°C.

Solution 7S.

The greenhouses gases have an average warming effect on Earth's surface of about 15.5°C (or 60°F).

Solution 8S.

Global warming means the increase in average effective temperature near the earth's surface due to an increase in the amount of green house gases in its atmosphere.

Solution 9S.

With activities industrialization, deforestation, excess burning of fossil fuel, the concentration of green house gases has increased on earth's atmosphere. This increase in the amount of greenhouse gases present in atmosphere has caused the rise in atmospheric temperature.

Solution 10S.

The increase in green house gases due to activities like industrialization, deforestation, natural gas exploration, burning of biomass, natural gas exploration, more use of gadgets like refrigerators has caused the increase of green house effect.

Solution 11S.

At the poles, due to increase in temperature, the snow and ice will melt which will cause flood in coastal countries. The icebergs of dark land and oceans will melt, so the dark land and oceans will become uncovered and will absorb more heat radiations coming from sun, increasing the green house effect further.

Solution 12S.

Due to global warming, the snow and ice around the poles will melt and cause flood in coastal countries.

Solution 13S.

Due to melting of polar ice and glaciers, there will be rise in sea level on coastal wet lands. It would raise worldwise sea level, thereby, many big cities in the coastal areas will be covered by sea water.

Solution 14S.

Global warming will cause drastic changes in the patterns of wind, rainfall etc. Thus it will result in low agricultural yield.

Solution 15S.

1. Use of renewable sources of energy to generate electricity in place of generating electricity from the fossil fuels based power plants.
2. Controlling population through family planning, welfare reforms and the empowerment of women.

Solution 16S.

The tax calculated on the basis of carbon emission from industry, number of employee hour and turnover of the factory is called carbon tax.
This tax shall be paid by industries. This will encourage the industries to use the energy efficient techniques.

Solution 1M.

Carbon dioxide

Solution 2M.

Increase in temperature

Solution 3M.

Without green house effect, the average temperature of Earth’s surface would have been -18 °C.

Solution 4M.

The global warming has resulted in the increase in sea levels.