# PHYSICS
## Standard X

## Part - 2

Government of Kerala
**Department of Education**

**State Council of Educational Research and Training (SCERT) Kerala**

**2016**

KT-505/1/Physics-10 (E)Vol-II

## The National Anthem

Jana-gana-mana adhinayaka jaya he
Bharatha-bhagya-vidhata,
Punjab-Sindh-Gujarat-Maratha
Dravida-Utkala-Banga
Vindhya-Himachala-Yamuna-Ganga
Uchchala-Jaladhi-taranga
Tava subha name jage,
Tava subha asisa mage,
Gahe tava jaya gatha.
Jana-gana-mangala-dayaka jaya he
Bharatha-bhagya-vidhata,
Jaya he, jaya he, jaya he,
Jaya jaya jaya jaya he!

## Pledge

India is my country. All Indians are my brothers and sisters.

I love my country, and I am proud of its rich and varied heritage. I shall always strive to be worthy of it.

I shall give my parents, teachers and all elders respect, and treat everyone with courtesy.

To my country and my people, I pledge my devotion. In their well-being and prosperity alone lies my happiness.

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*Dear students,*

*You were provided with opportunities to observe your surroundings and engage in simple experiments and investigative activities in earlier classes. The classroom experience, undoubtedly, might have helped you to record the information systematically and assimilate ideas through discussion and analysis. While understanding the scientific approach, there should also be the attitude to take forward the skills to apply them in day-to-day life. Moreover, an eco-friendly perspective must be adopted too. All these, through direct experiences, enquiry and understanding preferably.*

*This textbook presents ideas in accordance with this. There are experiments, illustrations and explanatory details that enable the comprehension of these ideas. There are opportunities appropriate to the situation to make learning more enjoyable.*

*Go ahead, thinking, asking questions, approaching ideas critically and quizzing with teachers and friends.*

*Make learning a joyful experience.*

*Regards,*

**Dr. P. A. Fathima**
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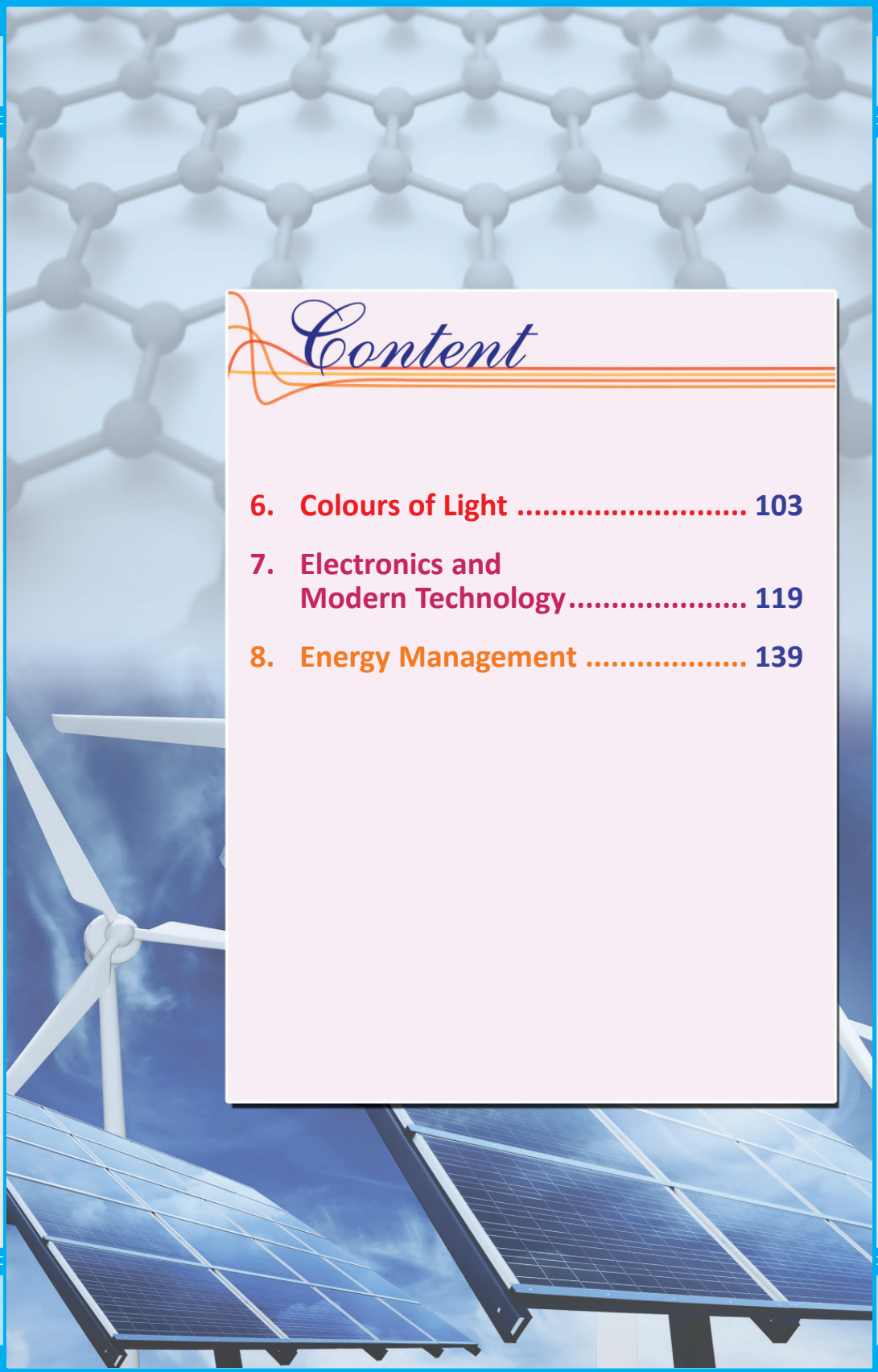


**Certain icons are used in this textbook for convenience**

*For further reading (Evaluation not required)*

*ICT possibilities for making concepts clear*

*Significant learning outcomes*

*Let us assess*

*Extended activities*

# 6 Colours of Light

*Flowers of various colours, the blue sky, colours of the sky during sunrise and sunset, red colour of the setting sun, rainbow – what a myriad of hues!*

*How are these various colours formed?*

## Dispersion of light

Sunlight passing through a prism may be allowed to fall on a screen. What are the colours seen on the screen?

- Violet
- Indigo
-

Is it the sunlight alone that gets disintegrated into component colours?

Let's examine.

What happens when white light from a torch is allowed to fall on a prism?

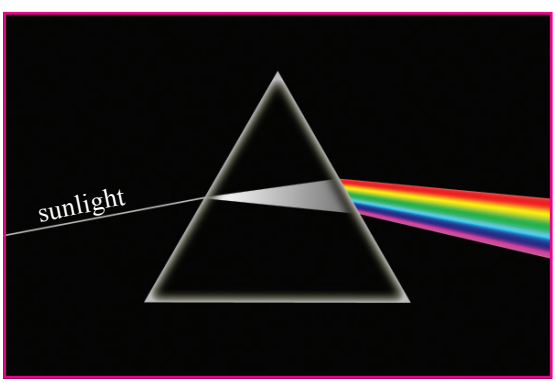



Fig 6.1

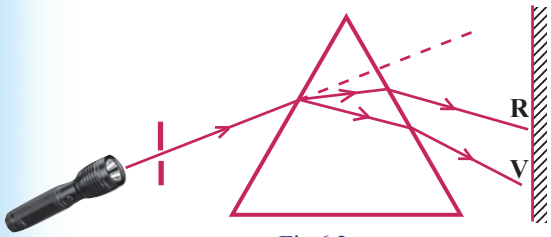



Fig 6.2

Affix a black paper on the glass cover of a torch.

Make a small hole at the centre of the black paper. Arrange a screen on the other side of the prism. The beam of white light from the torch is allowed to fall obliquely on the prism. What do you observe on the screen?

- Which are the colours formed on the screen?
- Aren't these colours the same as the component colours obtained from the sunlight?

*Any light that is composed of more than one colour is a composite light.*

*Dispersion is the phenomenon of splitting up of a composite light into its constituent colours. The regular array of colours formed by dispersion is the visible spectrum.*

Observe figure 6.2.

- Which colour deviates the most due to dispersion?
- Which colour deviates least?

What may be the reason behind this deviation?

Examine the given table:

| Colour | Wavelength (nanometre) |
|---|---|
| Violet (V) | 400 – 440 |
| Indigo (I) | 440 – 460 |
| Blue (B) | 460 – 500 |
| Green (G) | 500 – 570 |
| Yellow (Y) | 570 – 590 |
| Orange (O) | 590 – 620 |
| Red (R) | 620 – 700 |

Table 6.1

- Which colour has the shortest wavelength?
- Which one has the longest?
- As the wavelength increases, how does the deviation change? Will it increase or decrease?

On the basis of the experiment and the given table, write down your inferences.

Light undergoes refraction when it enters the prism obliquely and when it comes out of the prism. The extent of deviation depends on the wavelength. Therefore waves undergo deviation at different angles and get separated. This is the reason for dispersion.

Does dispersion occur only when light passes through a prism?

Let's examine.

## Rainbow

All of you would have seen a rainbow.

On a sunny day, spray water into the atmosphere in the direction opposite to the position of the sun in the sky. What do you observe? Colours of light appear. Compare the spectrum of light thus obtained with that of the rainbow.

- When is the rainbow formed?
- Where will be the sun when the rainbow is seen in the east?
- Where will be the sun when the rainbow is seen in the west?

Dispersion of light caused by the water droplets in the atmosphere causes rainbow.

How does dispersion occur when light passes through the droplets of water?

Fig 6.3

*Sunlight, when it passes through water droplets, undergoes refraction and internal reflection. All the water droplets of the same colour appear to be in the same arc of a circle. There is red colour at the outer edge and it is violet colour at the inner edge. All the other colours are seen in between, depending on their wavelengths.*

Observe Fig 6.4. Analyse the information given and answer the following questions.

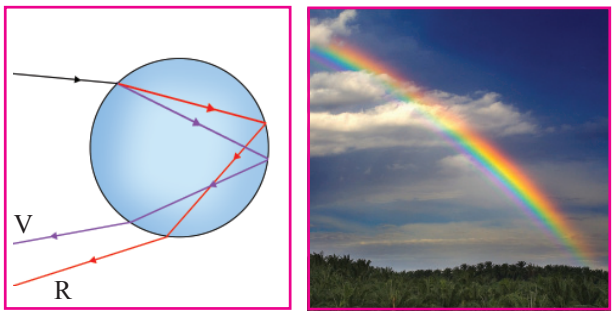



Fig 6.4

- How many times does a ray of light undergo refraction when it passes through a water droplet?
- What about the internal reflection?
- What is the colour seen at the outer edge of the rainbow?
- What is the colour seen at the inner edge?

### The arc form of rainbow

Line of vision is the line connecting the centre of rainbow and the eye of the observer. The rays of light incident on the water droplets must be parallel to the line of vision. Each colour ray emerging from the water drop makes a definite angle from 40.8° to 42.7°. Of these, the higher angle 42.7° is made by the red. The violet makes the lower angle of 40.8°. Hence red colour is seen on the upper edge and violet on the lower edge.

When the position of the sun is near the horizon, the rainbow appears to be bigger. When seen from an aeroplane, the rainbow is seen as a circle. When the sun is much above the horizon, the rainbow disappears.

You have understood many facts about visible light and its constituent colours.

If the constituent colours are mixed together, will you be able to obtain white light?

Let's perform an activity.

## Recombination of colours

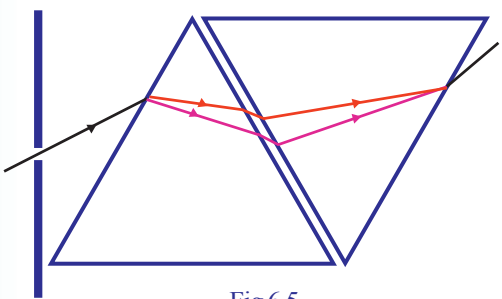


Fig 6.5

Pass white light through a prism and obtain the constituent colours on a screen. A similar prism is placed with it base on the upper side and adjacent to the first prism as shown in Fig. 6.5. What do you observe on the screen now?

- What happened to the light when it passed through the first prism?
- What happened when it passed through the second one?

Try out another activity as well.

You know how to make Newton's colour disc by painting the constituent colours of white light in the same order and proportion.

Fig 6.6

- In which colour does the disc appear when rotated fast?
- Give reason.

The disc appears white since all the rays of light from the seven colours reach the retina of the eye within

0.0625 second .

The disc appeared white due to persistence of vision. Find out more examples of persistence of vision and write them down.

- A torch rotated rapidly appears as an illuminated circle.
-

Do we obtain white light only when the seven colours combine?

### Persistence of vision

When an object is viewed by a person, its image remains in the retina of the eye for a time interval of 0.0625 s $\left(\frac{1}{16}\text{ s}\right)$ after seeing it. This phenomenon is called persistence of vision. If more than one scene is viewed within 0.0625 s, the effect of all these scenes will be felt by the eye simultaneously.

## Primary and secondary colours

Cover the illuminated portion of three torches with red, green and blue glass papers. Switch on the torches and project them on a white wall in such a way that they superimpose.

- What is the colour of the region where colour lights from all the three torches superimpose?

Fig 6.7

Are you convinced that white light can be obtained by combining the three colours of light blue, green and red?

- What is the colour of the region where blue and green alone combine?
- What is the colour of the region where blue and red alone combine?
- What is the colour of the region where green and red alone combine?

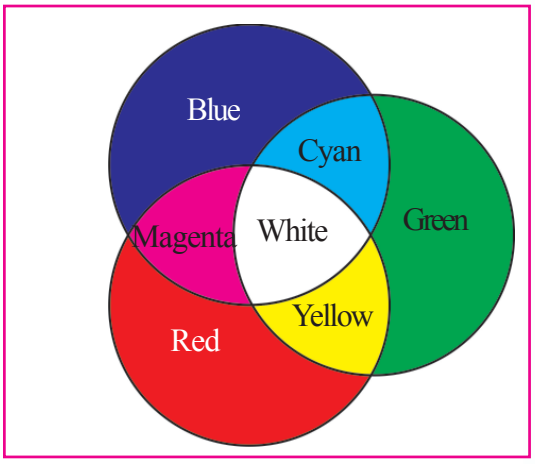



Fig 6.8

Replace the transparent papers of blue, green and red by transparent papers of other colours for covering the torches and superimpose the lights of different colours on the wall. Check whether it is possible to obtain blue, green and red by superimposing other colours.

Haven't you seen that it is not possible to obtain blue, green and red by superimposing other colours.

*By suitably superimposing blue, green and red, it is possible to make white light or other colours. But it is impossible to make blue, green and red by combining other colours. Hence, blue, green and red are the primary colours of light.*

The colour obtained by combining any two primary colours of the same intensity is a secondary colour of light.

Complete the following table on the basis of the activity done.

| Primary colours | Secondary colours |
|---|---|
| Green + Red | Yellow |
| Red +..... | Magenta |
| .....+..... | Cyan |

Table 6.2

*See 'Colour vision' in PhET of IT @ School, Edubuntu.*

## Complementary colours

Let's examine whether we will get white light by combining any colour with any of the secondary colours.

Combine blue and yellow colours and allow it to fall on a white wall. What is the colour seen? Why?

- Repeat the experiment using magenta and green. What is the colour obtained?
- If cyan and red are used, what colour do you obtain?

Blue is a primary colour. Yellow contains the primary colours green and red. When yellow combines with blue, white light is produced. Similarly magenta and green combines to give white. Also, cyan and red can combine to give white. Record these observations in your science diary with reasons.

If white light is formed by combining two colours, they are said to be complementary to each other.

*If white light is formed by combining a primary colour and a secondary colour, the two are mutually complementary.*

| Colour | Complementary colour | Colour obtained |
|---|---|---|
| Green | Magenta | ..... |
| ..... | Blue | White light |
| Red | ..... | White light |

Table 6.3

*It was deep blue when I saw it at the textile shop. How did it change its colour?*

Fig 6.9

Have you ever had a similar experience? What is the reason? Let's examine

## Colour of opaque objects

Place a red paper on a table in a dark room. Allow light from a torch to fall on the red paper obliquely. Hold a white paper facing the red paper, as shown in the figure.

- What is the colour of light reflected from the red paper?

Fig 6.10

- When the reflected light falls on the white paper, what is the colour seen?

Repeat the experiment using green and blue light.

When these colours fall on white paper, what are the colours reflected?

- What is the relation between the colour of an opaque object and the colour of light reflected by it?
- Allow red light to fall on a white paper. What will be the colour of the paper?
- When blue or green colour fall on a white paper, what will be the colour of the paper?
- What is the colour of an object that reflects all colours?
- If an object does not reflect light of any colour, how will it appear?

The colour of an opaque object depends upon the colour it reflects. The colour an object reflects, when placed in sunlight, is its original colour. A white object does not absorb any colour. It reflects all the colours falling on it. Similarly, an opaque object that absorbs all the colours of the white light that fall on it will be seen as black. It does not reflect any colour.

We see an opaque object in the colour it reflects. The original colour of an object can be seen only in white light. That is why it becomes difficult to identify the actual colour of clothes placed under different fancy coloured lights.

*The colour of an opaque object is the colour of light it reflects in white light.*

## Colour of transparent objects

Objects that transmit light are transparent objects. Let's examine the factors on which their colour depends.

Allow white light coming from a torch to fall on a white wall through a green filter.

### Colour pigment

Colour pigments such as cyan, magenta and yellow are used to make other colour pigments. Hence these three colour pigments are the primary colour pigments. Colour pigments reflect their own colours and all the other colours are absorbed . For example, a colour pigment that absorbs red light alone from white light and reflects green and blue lights, will be seen as cyan. Similarly, yellow pigment absorbs blue light alone and magenta absorbs green light alone. All pigments are made of cyan, magenta and yellow (cmy). Hence these are the primary colours of pigments.

Suppose cyan and yellow pigments are mixed. Cyan pigment absorbs red light and yellow pigment absorbs blue light. Hence if yellow and cyan pigments are mixed in equal amounts, the mixture will reflect green light and it will be seen as green. If cyan, magenta and yellow pigments are mixed in equal amounts, all colours will be absorbed and it will be seen as black.

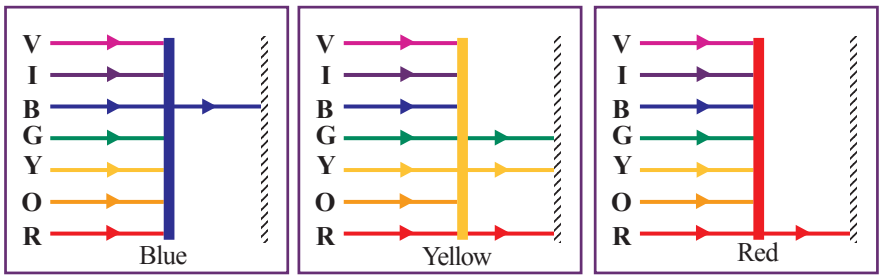



Fig 6.11

- What is the colour of light falling on the wall?

All the other colours in the white light have been absorbed by the filter. Is it not the reason for this colour?

A transparent material appears in the colour of the light it transmits. If a transparent material transmits all the colours in white light, it will not have any colour. Water is colourless. Why? Note down in your science diary.

## Colour filter

*Colour filters are transparent materials which allow the passage of certain colours alone through them. Green, blue and red filters allow only the respective colours to pass through them. Yellow, magenta and cyan filters pass their component colours also through them.*

- What is the colour of a red flower when looked through yellow filter?
- If a green filter is used, what will be the colour?
- White light is passed through green and red filters and allowed to fall on a white paper. What will be the colour of the paper?

Apart from visible light, is there any other radiation in the solar rays? Let's examine.

### Solar spectrum

Observe the figure :

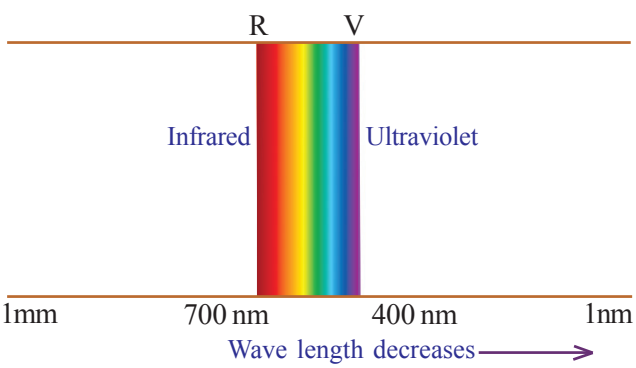



Fig 6.12

- In the solar spectrum, which radiation is close to red and has a wavelength greater than red?
- Which is the radiation that is close to violet and has a wavelength less than violet?

- When solar radiations are allowed to pass through a prism, which are the radiations that are not visible?

All the radiations in the sunlight, are a part of a wide spectrum known as electromagnetic spectrum. Let's see which are the electromagnetic waves that are present in addition to the visible light.

Look at Fig 6.13.

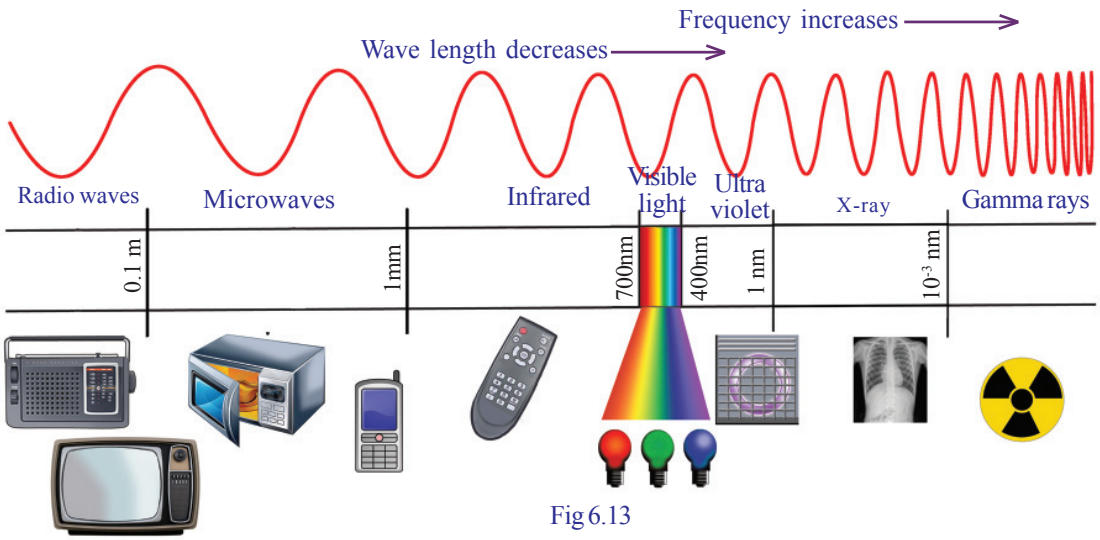



Fig 6.13

**Infrared**
- Comes out from hot objects due to the vibrations of the molecules in them.
- Makes sunlight hot
- Used in remote control and night vision camera

**Visible light**
- Causes sense of vision
- Helps to produce energy by photo synthesis
- Used in the solar cells

**Ultraviolet**
- Absorbed by the ozone layers
- Helps to produce vitamin D in the skin
- Likely to cause skin cancer
- Affects vision if exposed to excess radiation

**X-ray**
- Penetrates through flesh
- Helps to detect defects of bones, breakage of pipes in industrial concerns etc.
- Dissociates DNA, hence excessive exposure causes cancer

**Electromagnetic spectrum**

**Gamma rays**
- Causes damage to living cells
- Comes out in large quantities during nuclear fission
- Used in cancer treatment
- Useful in sterilizing surgical instruments

**Radio waves**
- Used for very high frequency radio transmission.
- Used for ultra high frequency television transmission.

**Microwaves**
- Used in radar and mobile phone
- Used in microwave oven

- Name the highest and the lowest frequency waves in the electromagnetic spectrum.
- Which are the electromagnetic waves capable of producing heating effect?

During sunset, you might have noticed that the western horizon becomes reddish. Why is it so?

## Scattering of light

Fig 6.14

Even though light travels in straight lines, we get light in our classrooms and houses during day time. Have you thought about this?

When sunlight passes through the atmosphere, rays of light are reflected by tiny particles of the atmosphere (dust particles, molecules etc.) as shown in Fig. 6.15.

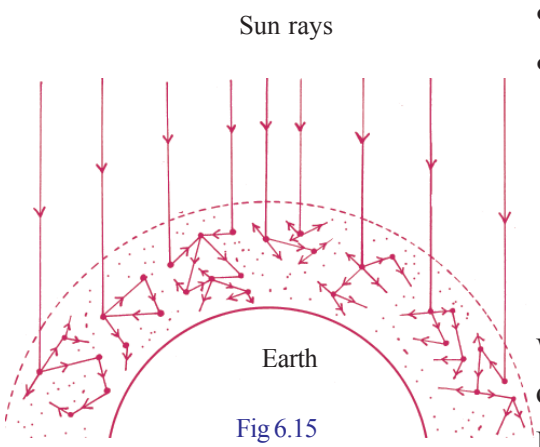



Fig 6.15

- Is the reflection here regular or irregular?
- For the distribution of sunlight everywhere in the atmosphere, can this type of reflection be held responsible?

Discuss.

*Irregular and partial reflection of light is scattering.*

Will all the colours of sunlight undergo dispersion on the same scale?

Let's examine.

Water is taken in a beaker as shown in Fig 6.16. Allow light from a torch to fall on the water from one side of the beaker. The light emerging from the beaker is focussed on a white screen. Sodium thiosulphate is dissolved in water in the beaker. 2 g of sodium thiosulphate is required for 50 ml of water. Add one or two drops of hydrochloric acid to the water in the beaker. Observe the gradual change in the colour of light in the solution and on the screen.

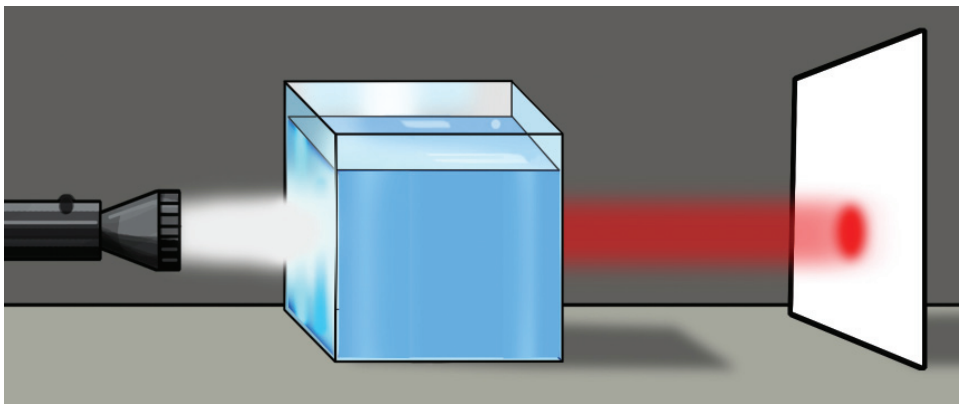


Fig 6.16

- When hydrochloric acid was added to the solution, which colour did spread in the solution at the beginning?
- Write down the colour change on the screen step by step as it occurred.
- What was the final colour on the screen?

When sodium thiosulphate reacts with hydrochloric acid, colloidal sulphur is precipitated. Discuss the change in the rate of scattering and its relation to the wavelength of light as the size of sulphur particles gradually increases.

## Scattering and wavelength

Colours like violet, indigo and blue have the smallest wavelengths in sunlight. They undergo maximum scattering while interacting with atmospheric particles. Red has practically greater wavelength and it can overcome small obstacles and hence scattering is low. As a result they travel greater distances.

*Rate of scattering and the size of the particles are interrelated. As the size of the particle increases, the rate of scattering also increases. If the size of the particles is greater than the wavelength of light, then the scattering is same for all colours.*

- Which component colour in white light does undergo maximum scattering?

During sunset, the horizon appears to have red colour. Can you explain the reason?

## Colours of the rising and the setting sun

Look at Fig. 6.17 and find out the answers for the following questions.

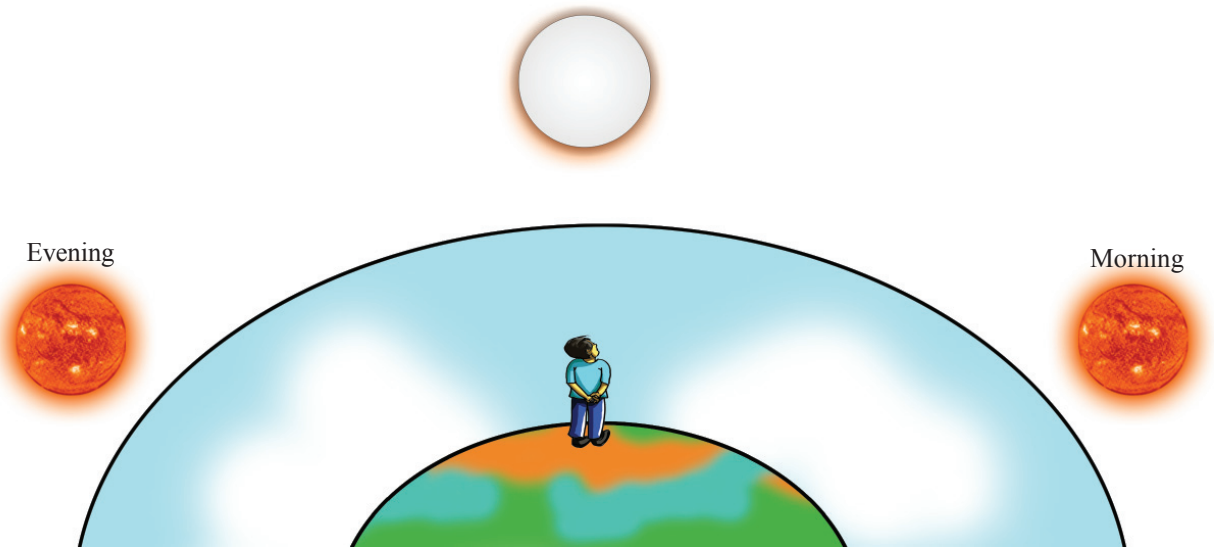



Fig 6.17

- Which are the occasions when sunlight has to travel greater distance through the atmosphere before reaching the eyes of an observer on the earth?
- When light reaches the observer after travelling long distances through the atmosphere, which colour reaches the eye? What is the reason?
- Even after sunset, the western horizon continues to have red colour for some more time. Why?

Light reaching us from the horizon has to travel long distances through the atmosphere. During this long journey, colours of shorter wavelength would be almost fully lost due to scattering. Then, the red light which undergoes only less amount of scattering decides the colour of the horizon. That is why the horizon appears red during sunset and sunrise.

You have gone through the discussions on the scattering of light.

Can you now guess why red colour has been given to the tail lamps of vehicles and signal lights? Note down in your science diary.

During day time, the colour of the clear sky is blue. Why is it so?

## Blue colour of the sky

Sunlight reaches us through the atmosphere. When the sunlight falls on minute particles in the air, the light undergoes scattering.

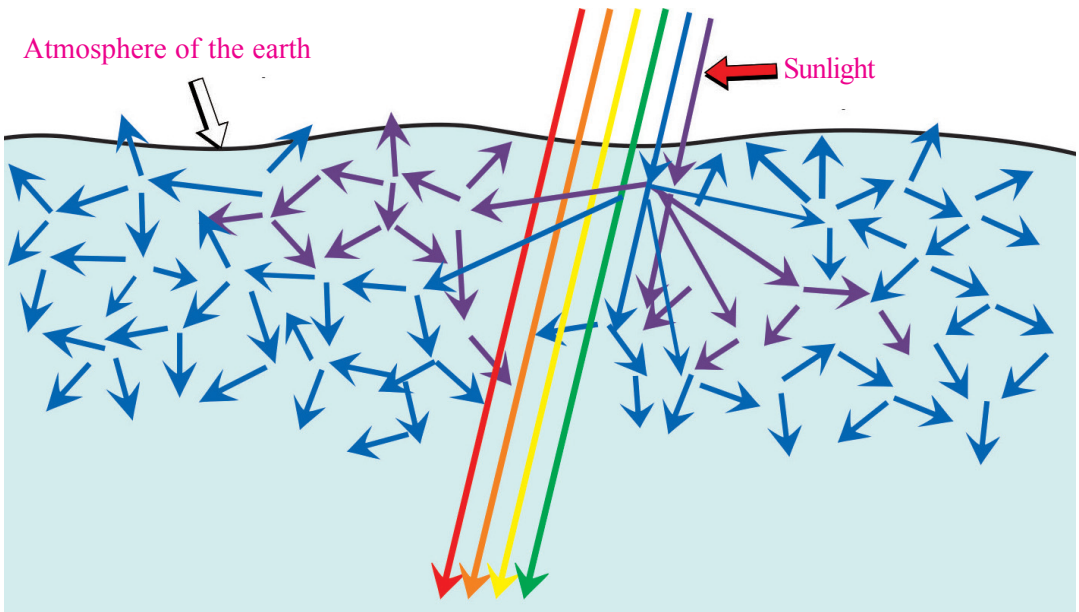



Fig 6.18

- Which are the colours that scatter more?

  What is the reason?

Discuss this aspect on the basis of the experiment using sodium thiosulphate and hydrochloric acid. Write down your inferences in your science diary.

*Component colours like violet, indigo and blue, which are of shorter wavelength in sunlight, undergo maximum scattering in the atmosphere. These colours spread in the atmosphere and the combined effect of these colours is seen as the blue colour of the sky during daytime.*

- The sky is dark in the moon. What is the reason?
- When observed from the moon, stars can be seen even during daytime. Discuss the reason and write it down in the science diary.

## Tyndal effect

Look at the figure.

A misty morning

Fig 6.19

The path of rays of light can be seen clearly. How is it possible?

When rays of light pass through a colloidal fluid or suspension, the tiny particles get illuminated due to scattering. Because of this, the path of light is made visible. This phenomenon is Tyndal effect. The intensity of scattering depends on the size of particles in the colloid.

You would have now understood the relation between wavelength and scattering of light. Infrared radiations have greater wavelength than red. What is the use of infrared radiations which have much less scattering?

## Infrared photography

Infrared radiations are used to take photographs of distant objects. Arrangements which are sensitive to infrared radiations are used in them. Since they are sensitive to visible light also, infrared filters allow infrared radiations alone to pass through them while visible light is completely absorbed.

- Are the wavelengths of infrared radiations greater or lesser than that of visible light?
- What about the rate of scattering?

Find out the other uses of infrared rays and list them in the science diary.

## Significant Learning Outcomes

*The learner can*

- explain that composite light is subject to dispersion and that the deviation of each component colour depends on the wave length.
- explain the formation of rainbow and its peculiarities.
- explain how composite light is obtained with the help of experiments.
- explain persistence of vision with the help of examples.
- indulge in experiments for identifying primary and secondary colours and explain the results of combination of colours.
- explain the features of solar spectrum.
- explain practical aspects of scattering.
- explain the reason for original colours of transparent and opaque objects and the difference of colours of objects in artificial light.

## Let us assess

1. Which is the phenomenon responsible for dispersion of light?
   a) Reflection
   b) Refraction
   c) Tyndal effect
   d) Scattering
2. During dispersion, different colours deviate differently. Explain the reason for it.
3. Green and red colours are allowed to fall on a white cricket ball simultaneously. What will be the colour of the ball? Justify your answer.
4. What do you mean by electromagnetic spectrum?
5. The telescope 'Chandra' is placed in the space. What is the advantage of placing it there? Explain with reference to the scattering of light in the atmosphere.
6. If a plant with green leaves and red flowers is kept in light with

the following colours, what will be the observed colours of leaves and flowers?

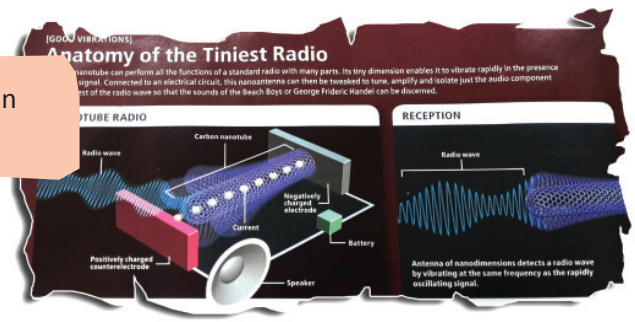
1. Green
2. Yellow
3. Red
4. Blue

## *Extended activities*

1. White light is allowed to fall on the bright side of a compact disc (CD). The reflected light is allowed to fall on a white wall. Observe the colours available in the spectrum and write them down in the science diary.
2. Observe the colours of light coming out of the CD through filters of different colours and record your observations in your science diary.

# 7 Electronics and Modern Technology

**Drone:** a messenger; one who distributes required materials to consumers; one who warns accurately about the pests in agricultural areas; a farmer's friend who does manuring judiciously.




A carbon nanotube can function as a radio.

Given above is an excerpt from a science article on modern devices like the Internet which are capable of changing our social life.

Don't you feel that you should know about such ideas and devices? It is the growth of science in different fields that has led to the production of such devices.

It is a scientific fact that current will be induced in a conductor if it experiences a change of magnetic flux. Isn't it based on the above idea that electricity is produced on a large scale in power stations? Bringing scientific concepts and principles into an application level like this is technology.

*Technology is the application of science.*

Technological achievements have highly influenced social life. Examine the following and find out examples for such changes in other fields and write them down.

- Discovery of electricity
- Wireless communication
- Remote sensing
- Thermal photography
-

Twentieth century was considered the electronic age. It was the technology of using the electrons by controlling their flow that led to the production of a variety of electronic devices. This paved the way for major changes in social and scientific fields.

*Electronics is the branch of science that deals with the study of nature of electrons, their control and use.*

Take a look at the list of some electronic devices that are used in daily life. Find out more examples and expand the list.

- Radio
- Television
- Digital meter
- LED bulbs
- Solar panels
-

Which are the basic components used in such electronic devices?

Examine the circuit boards of defunct radio, electronic ballast, CFL, motherboard of a computer etc.

Identify them by comparing with Table 7.1 and record.

Let's examine the functions of these components in the circuits.

resistors
Fig. 7.1

## Resistors

The function of a resistor is to supply necessary potential difference to components, by regulating the current in a circuit. The value of resistance is recorded either directly on it or using a colour code. Haven't you learnt about it in earlier classes?

- What is the function of a resistor in a circuit?
- What is the unit of resistance?
- Draw the symbol of a resistor.

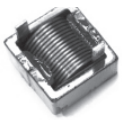
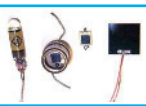
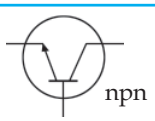
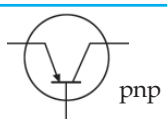
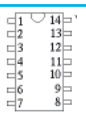
| Components | Type | Figure/photo | Symbol |
|---|---|---|---|
| 1. Resistors | Carbon resistor |  |  |
| | Wire wound resistors |  | |
| | Variable resistors |  |  |
| 2. Inductors | Fixed inductor |  |  |
| | Variable inductor |  |  |
| 3. Capacitors | Fixed capacitors |  |  |
| | Variable capacitor |  |  |
| 4. Diodes | Diodes |  |  |
| | Light emitting diode (LED) |  |  |
| | Photo diode |  |  |
| | Zener diode |  |  |
| 5. Transistors | npn |  |  |
| | pnp |  |  |
| 6. I C Chips | |  |  |

Table 7.1

Different types of inductors
Fig. 7.2

## Inductors

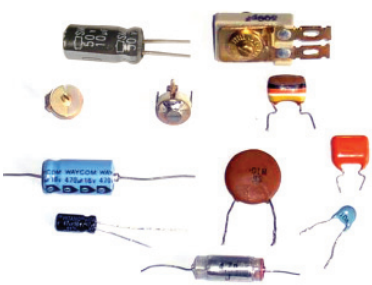
Inductors are coils of conducting wire which can resist variations of electric current in a circuit without energy loss. The ability to resist changes is the inductance. You have already learnt about self induction. Inductors work on this principle. The unit of inductance is henry (H). The practical unit is milli henry (mH).

- What is the function of inductors in circuits?
- What is the advantage of an inductor over a resistor?
- What are the limitations of inductors?

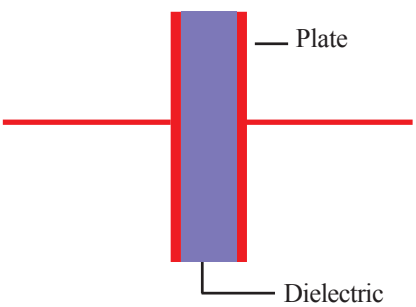
## Capacitors

| | | |
|---|---|---|
| Microfarad (μF) | = | $10^{-6}$F |
| Nanofarad (nF) | = | $10^{-9}$F |
| Picofarad (pF) | = | $10^{-12}$F |

Capacitors are components used to store electric charge and release it when necessary. A capacitor is made by placing a dielectric between two parallel metal plates. Capacitance is the ability of a capacitor to store charges.



Different types of capacitors
Fig. 7.3 (a)




Structure of capacitor
Fig. 7.3 (b)

The unit of capacitance is farad (F). Usually the practical units microfarad (μF) and picofarad (pF) are used. A capacitor is known by the name of the dielectric used in it.

Take a defunct paper capacitor, open it, observe the parts and write them down.

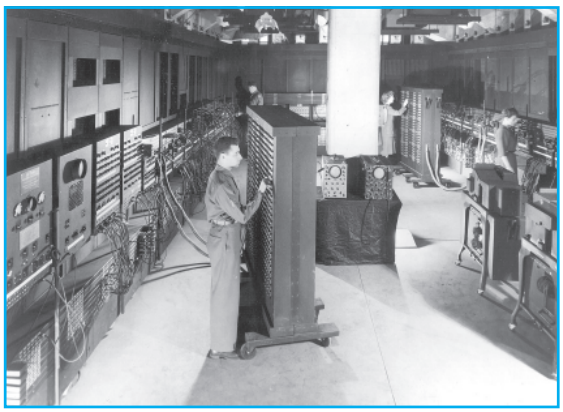
- Aluminium foil
- 
- Why is it called paper capacitor?


Capacitors which use electrolyte in between the plates are electrolytic capacitors.

In the electrolytic capacitors, the sign positive (+) or negative (-) will be marked near the leads. The positive lead from a capacitor should be connected to the positive of the circuit and the negative lead from the capacitor, to the negative of the circuit.

## Semiconductors

Haven't you heard of Eniac (Electronic Numerical Integrator and Calculator - ENIAC), the first electronic computer which was assembled in 1940s?



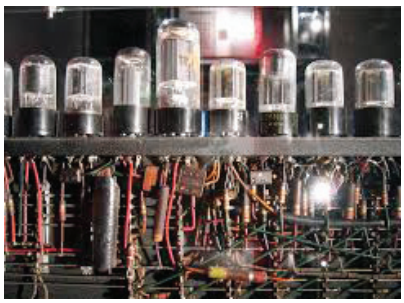


Fig. 7.4

Eniac, which was very big and heavy, was made using more than 18000 vacuum tubes. Compare it with the laptop of today, which has thousands of times more efficiency and is much smaller in size.

Have you ever thought how it is possible? It was the study of semiconductors that led to the huge changes in the field of modern electronics.

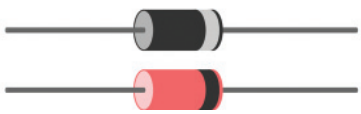
You might have learnt that substances can be classified into conductors and insulators on the basis of conductivity. But there are some substances whose conductivity is in between that of an insulator and a conductor. Such substances are semiconductors. Germanium and silicon are the main semiconductors.

### Vacuum tubes

A vacuum tube is an arrangement of evacuated glass bulb, with electrodes fitted inside. They are much bigger than the diode and the transistor and consume higher power.

*The conductivity of semiconductors can be increased by suitably adding certain other elements. This process is doping. We can make two types of semiconductors, namely, p - type and n - type, by adding suitable elements.*


Different types of diodes



(a) Diode

(b) Symbol of diode

Fig. 7.5

We can use semiconductors suitably by bringing appropriate changes in their conductivity through doping. It was the application of this scientific principle that led to the production of diode, transistor, IC, etc. Let's familiarise with some such electronic components.

## Diode

Diode is an electronic component obtained by suitable doping of a semiconductor in such a way that one region is p – type and the other region is n – type.

See the diagram and the symbol of a diode.

At one end of some type of diodes there is a white marking. This is the n – region. Compare the figure of the diode with its symbol and identify the corresponding parts. Different types of diodes, working in high voltage and current as well as in low voltage and current, are available. One speciality of a diode is that it makes the flow of current unidirectional.

Let's see how a diode works in a circuit.

Make a circuit as shown in Fig. 7.6(a) by connecting two torch cells, a diode, a torch bulb and a switch in series. What do you observe?

- Bring a change in the circuit as shown in Fig 7.6(b). Record your observations.

Write down your inferences derived from these activities.

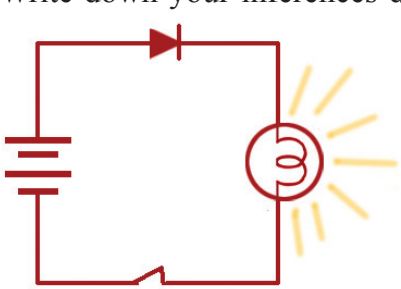


Fig. 7.6 (a)

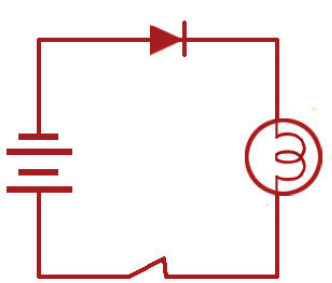


Fig. 7.6 (b)

*Current flows through a diode on connecting the p-region of a diode to the positive terminal of a cell and the n-region to the negative terminal. Connecting a diode in this manner is forward biasing. Current does not flow if the p-region of a diode is connected to the negative terminal of a cell and the n-region, to the positive terminal. This method of connecting a diode to a circuit is reverse biasing.*

## Light Emitting Diode

Haven't you seen certain diodes emitting light when current passes through them? Such diodes are light emitting diodes (LED). They are made of certain semiconductors. The light emitted by LEDs depends on the material with which they are made. Nowadays LEDs which emit red, orange, yellow, green, blue and white lights are available.

Repeat the activity in Fig 7.6(a) by replacing the bulb by LED. What are your inferences?

LEDs are widely used as indicators in electronic devices since their power consumption is very low. Find out more uses of LED and expand the list.

Uses of LEDs:

- Head lamps of vehicles
- Tail lamps
- Light show
- Traffic signals
- Display boards
- 
- 

Why are LEDs used widely as indicators? Write it down.

Fig. 7.7

### Light emitting diodes

LEDs are diodes that emit light when they are forward biased.

Peculiarities of LEDs:

- Low energy consumption
- Small in size
- Long lasting
- Low cost
- Lights of various colours
- Unaffected by temperature variations

## Rectification

Make a circuit as shown in Fig. 7.8. T is a step down transformer and D is a diode.

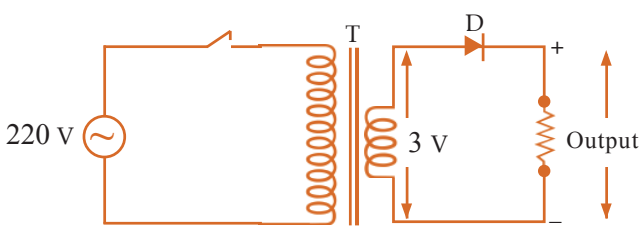
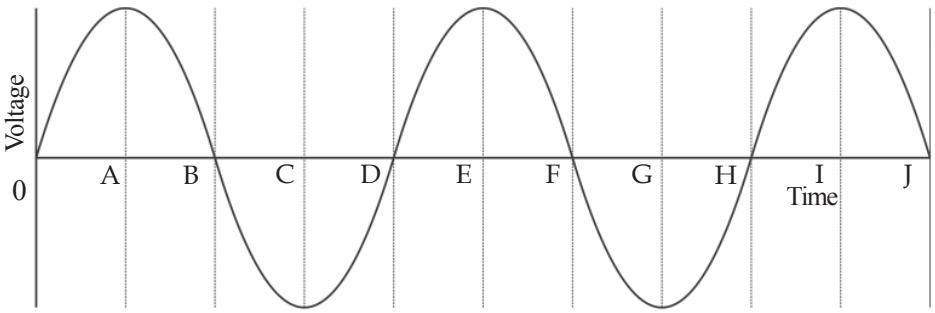



Fig. 7.8

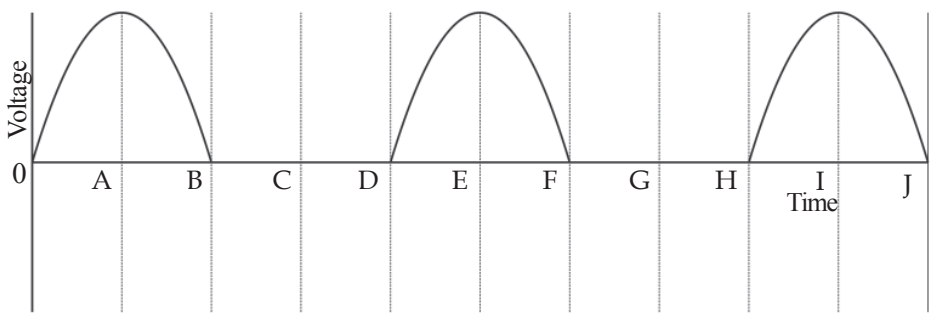
The graphic representation of AC supplied to the diode is depicted in Fig. 7.9 (a).




The graph of voltage from an AC source
Fig. 7.9 (a)

Fig. 7.9(b) shows the output voltage of this circuit.

*See 'KTech lab' in the IT @ School Edubuntu*




Graph of the output voltage
Fig. 7.9 (b)

Analyse the figures 7.9(a) and (b) and write down the peculiarities of the output voltage.

- Intermittent
- Current flow is only in one direction
- Voltage is fluctuating

Haven't you seen that half a portion in the graph is eliminated? When AC flows through a diode in this manner we get a current flow only in one direction which is intermittent. This is half wave rectification. The device which makes this possible is the half wave rectifier.

You have seen that AC can be made into intermittent DC using a half wave rectifier. Let's see how a continuous DC can be obtained from an AC source.

## Full wave rectification

Observe the given circuit. Suppose its input is AC.

- Which diode is forward biased when the end A is positive and the end B is negative?

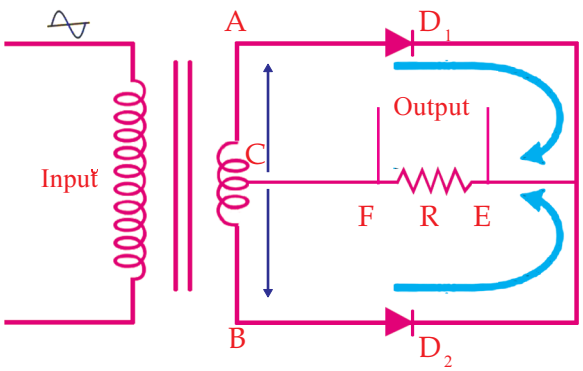



Fig. 7.10

- Then what about the direction of current through the resistor R?

Is it not from E to F? Now which diode is forward biased when the end B is positive and the end A is negative? Even at that time, isn't the direction of current in R from E to F?

If so, try to draw the graph of current through R.

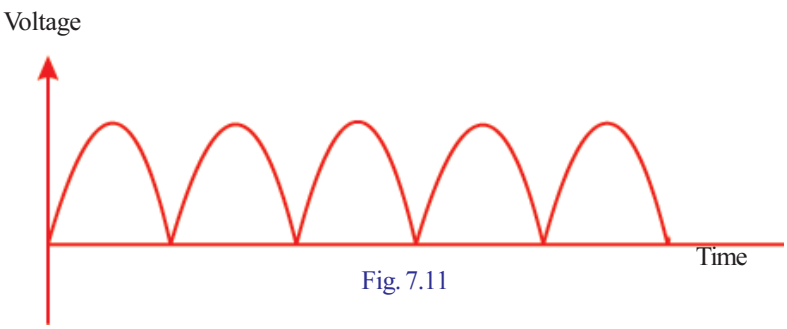



Fig. 7.11

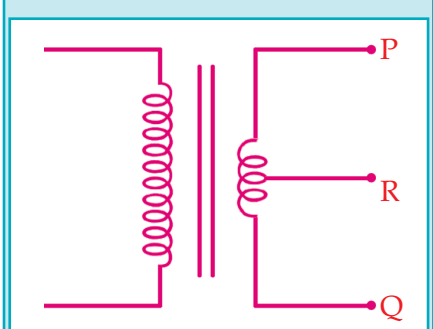
- What inference do you arrive at, on analysing the graph?

We get continuous current in the same direction in the output.

Such an arrangement which converts AC into a continuous unidirectional current is the full wave rectifier.

### Centre tapped transformer

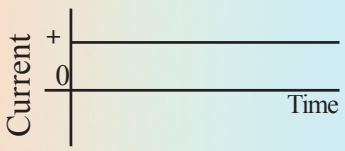
Unlike other transformers, this is a kind of transformer in which a wire is taken from the midpoint of the secondary coil. When AC passes through the secondary, let P be positive. If so, the end Q is negative. What about R which is in between P and Q? It is negative with respect to P but positive with respect to Q. That is, on considering the upper half (PR) alone R is considered as negative. If we consider the lower half alone (RQ) R is negative, when Q is positive. Transformer with such an arrangement in the secondary is the centre tapped transformer.



*The arrangement for converting AC into continuous unidirectional current is the full wave rectifier.*

## DC (Direct current)

A current which flows always in one direction is DC.




Graphic representation of current from a battery

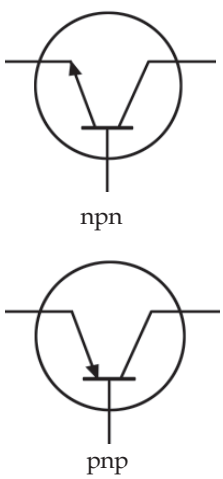
Cell, mobile phone battery, battery of vehicles, etc., are sources of DC.

You have now understood how diodes work, haven't you?

In the field of electronics, the invention of transistors is an advancement from diodes.

## Transistors

Haven't you learnt the working of a diode? A transistor is another electronic component made using semiconductors. There are three terminals in a transistor. There are hundreds of models of transistors depending on the nature of material used for making, method of making, etc. Transistors are used in electronic circuits for executing various functions. There are two types of transistors – npn transistor and pnp transistor.


Transistors
Fig. 7.12

A diode is an arrangement in which a part of a semiconductor crystal is p – region and the other is n – region. Like this npn transistor is a semiconductor crystal arrangement with a p - region in between two n - regions.

In that case, how will the structure of a pnp transistor be?

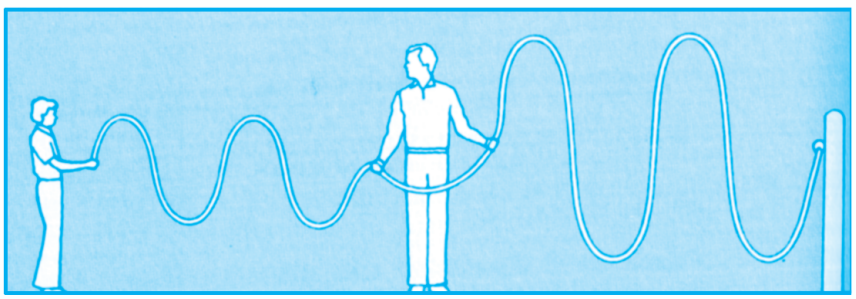
Amplification is one of the functions of a transistor.

## Amplification

We have already learnt that microphone can be used to convert sound waves into electrical signals. Such signals are audio signals. These

signals are incapable of making the voice coil of a loud speaker vibrate. Hence these signals are to be strengthened.

*Amplification is the process of strengthening electric signals.*



Amplifier: A schematic diagram

Fig. 7.13

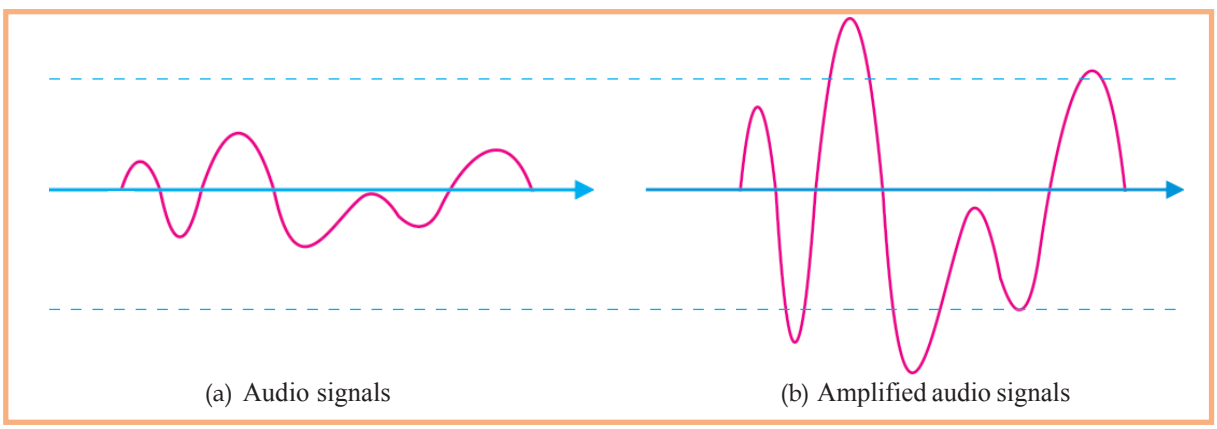



Fig. 7.14 Amplification of audio signals

Observe the Figs. 7.14, 7.15(a) and (b).

Is there a change in the number of cycles within a specific time before and after amplification? Do you see any other change in the waves? From this what inference do you arrive at?

The amplitude increases as a result of amplification but there is no change in the frequency.

## Integrated circuits

You are now familiar with the components like resistor, capacitor, transistor, diode etc., used in electronic

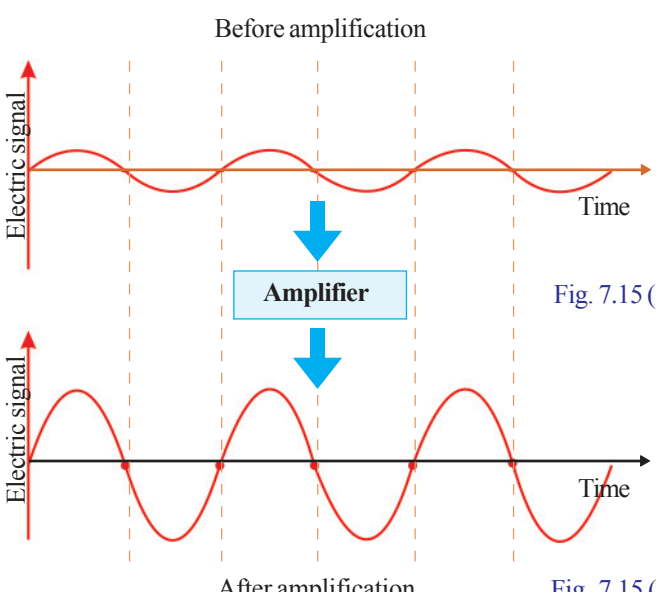
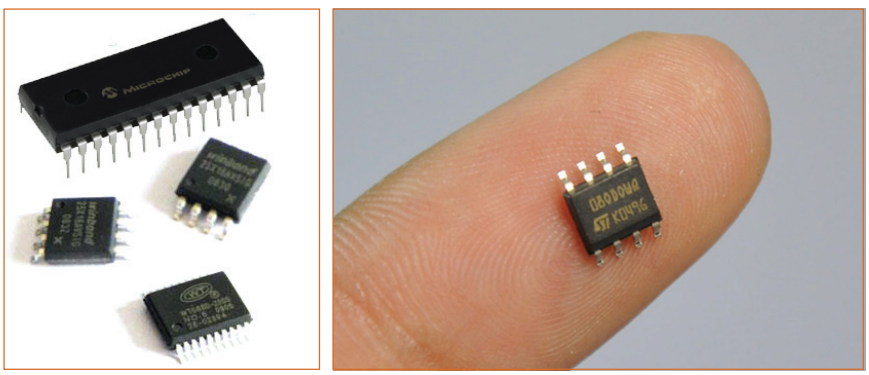



Fig. 7.15 (a)

Fig. 7.15 (b)

| ICs | Significant/Major uses |
|---|---|
| 555 | For devices like timer etc. |
| 810 | As an amplifier |

circuits. You will have to use thousands of electronic components in complex circuits. If so, can't you guess what the size of the circuit will be! But we have been able to incorporate the functions of lakhs of electronic components into a tiny semiconductor crystal. This arrangement is the integrated circuit or IC chip.



(a) Different types of ICs (b). The size of an IC is compared to the size of a finger

Fig. 7.16

## Microprocessor

The number of transistors incorporated in the processor 8008 which came out in 1972 was 3500. Ten years later, in 1982 came out the processor 80286, in which the number of transistors incorporated was 134000. Again, in 1993, the Pentium processor containing 31 lakh transistors reached the market. The size was still the same! In 2002, the processor Pentium - 4 which contained 550 lakh transistors found a place in the market. What about the latest? Do you know the number of transistors in Core - i7 which was brought out in March 2010? 170 crores!

An integrated circuit chip (IC chip) is an arrangement incorporating the functions of a lot of transistors, diodes, resistors, capacitors, etc., in a semiconductor chip.

Let's see the importance of IC chips

- Ability to minimise the size of electronic devices since the function of crores of transistors and other components are incorporated in a chip
- Ability to ensure high efficiency
- Credibility
- Low energy consumption
- High longevity
- Ability to resist temperature variations up to a certain extent.

Do you know that the first computer occupied a big building itself? What is the situation today? Pocket - sized computers are available in the market.

This has been made possible with the introduction of integrated circuits. The processor of computer is an integrated circuit.

Micro processor is an arrangement in which lakhs of transistors are incorporated inside a tiny chip.

Haven't you understood how the size of electronic devices gets reduced?

## Modern technology

Let's familiarise with some modern technologies using the advancement in electronics.

## Telecommunications

Mobile phones of different types with a variety of use are available in the market. Write down some telecommunication networks known to you.

- Internet
- Television
-

Let's see the technologies behind the development of these facilities.

## Photonics

Photonics is the branch of science that deals with the study of nature of photons, their control and use. Photons are the particles of light. Laser optics, fibre optics etc., are some of the branches of science related to this.

Write down some situations where we use laser optics.

- Barcode reader
- CD, DVD writer

Fig. 7.17

In olden days, wires were used in telephone systems. The discovery of the use of optical fibre for sending more data to distant places much faster paved the way for huge changes in the field of telecommunications. These changes are tabulated below.

## Growth in telecommunication technology

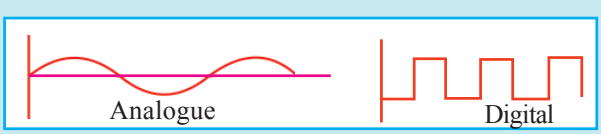
| Generation | Signals used | Specialities of messages |
|---|---|---|
| Ordinary telephone | Analogue | Sound signals alone. The speed is very low. |
| 1 G (Cellular technology) First Generation | Analogue | Sound signals alone. The speed is low. 2 kbps. |
| 2 G (Cellular technology) Second Generation | Digital | Sound signals, letters and internet. High speed and high accuracy. 384 kbps. |
| 3 G (Cellular technology) Third Generation | Digital signals sent through optical fibers as radio waves. | Sound signals, letters and the Internet. Very high speed and high accuracy. 2 Mbps. |
| 4 G (Cellular technology) Fourth Generation | Digital signals sent through optical fibers as radio waves. | Sound signals, letters, videos, Internet. Speed and accuracy very high. 100 Mbps speed. |

*5 G (fifth generation) is the next generation which will be acquiring a speed of 1 gigabyte per second (1 gbps)*

## Analogue, digital signal

In analogue systems, the changes in physical quantity at each instant are changed into continuous signals. These are signals with more accuracy. A large space is needed for storing data. This is used in watch, loudspeaker etc.

Digital signals are signals that can be represented using a maximum of two values alone, like yes/no, correct/wrong, on/off etc. They have better clarity. More data can be stored in a limited space. In computer, CD etc., digital method is made use of.




### WiFi (Wireless fidelity)

This is a method in which data is transferred using radio waves to link equipments, without connecting with wires. A system for transmission and reception of waves is essential for this.

- Using a single Wi Fi modem, more computers can be linked to the internet without wire connection.
- Data transference is possible using mobile phones.

### Digital camera

Digital cameras can convert pictures and scenes into digital signals. This is done by the image sensors in the camera. Films are not used in such cameras.

It is the number of pixels that decides the clarity of pictures. You might have heard

of 2 MP (2 mega pixel), 5 MP, 10 MP camera etc.

Find out devices that make use of small digital cameras.

- Drones
- Mobile phones
- CC TV
-


Fig. 7.18

## HD transmission

The full form of HD is high definition. This is decided depending on the maximum number of pixels in each frame. There are different types of HD transmissions. For example there is an HD transmission with 2,73,600 pixels.

Fig. 7.19

Write down the modern HD systems you are familiar with.

- Mobile phones
-

You would have now understood the concepts behind the growth in the field of telecommunication technology. More advancement is still possible in this field. Nanotechnology is one such new field.

## Nanotechnology

The word 'nano' means very small. Haven't you learnt that 1 nm is $10^{-9}$ m? One nanometer (1 nm) is the length that can be obtained when three atoms are laid side by side. Can't you guess how small it will be?

Nanotechnology is the branch of science that makes new substances and parts of devices using particles of size from 1 nm to 100 nm.

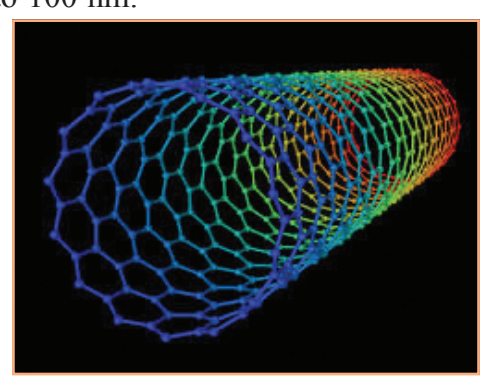


Fig. 7.20

### Nano particles

Man had known the characteristics of particles of nano size even before the development of science. Glass was given colours using tiny particles of gold and silver without knowing that they are nano particles. For example adding gold salts to glass gives it a red colour and silver salts give yellow colour. The phenomena created by nano particles are visible in nature. The optical phenomena seen when light falls on peacock feather , the ability of water not to stick on colocasia leaf and lotus and the sturdiness of spider web are some of them.

The ratio of surface area to the volume increases beyond a limit on changing them into nano size. Subsequently the physical properties of substances change very much since. This brings wide possibilities for nanotechnology.

For example, opaque objects will change into transparent (copper), non inflammable substance can undergo combustion (aluminium) substances without solubility can become soluble (gold).

Given below are some of the possibilities of the effective application of nanotechnology.

- bandages which can heal wounds faster
- highly efficient batteries.
- paint, varnish etc.
- display screens which are lighter.
- dresses and socks which are durable and give cooling in summer time.
- long lasting tennis ball.
-

Aren't you convinced that the use of nanotechnology is increasing in different fields?

Find out more uses of nanotechnology.

- Why is nanotechnology called so?

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- Which characteristic of substances does the field of nanotechnology make use of?

  - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Collect more information and arrange a seminar in the science club on how the advancement of nanotechnology can influence our future.

## Robotics

Robots are machines designed to perform those tasks which are both possible and impossible for human beings. They are also referred to as machine men.

*Robots are machines that perform their tasks by themselves or by remote control. Robotics is the branch of science which deals with the construction and uses of robots.*

Different fields employ different robots.

1. Industrial
   - To handle substances
   - Inspection robots
2. Mobile robots
   - Move on tracks or move using legs or wheels.
3. Robots for educational purposes
   - Robotic kits
   - Robolab
4. Domestic robots
   - For doing domestic chores
   - Modern toys
5. In the field of medical science
   - In the field of surgery
6. In the field of defence

Fig. 7.21

You would have now understood what robots are and that they are designed for various uses.

There are different types of small and big robots. Drone is one among them. They are officially known as UAVs (Unmanned Aerial Vehicles). Actually drones are robots that can fly. They can be automatic or remote controlled. Their flight is controlled by GPS using software.

Drones are used for different purposes. They have got wide acceptance due to their ability to perform with utmost accuracy, precision and cost effectiveness.

Electronics, as a branch of science, has grown so tremendously that it can understand even our physical activities with precision. Equipments like MRI Scanner (Magnetic Resonance imaging Scanner), Ultra Sound Scanner, ECG (Electro Cardio Gram), EEG (Electro Encephalo Gram) etc., are the achievements of this branch of science which has tremendous scope for further studies.

## Global Positioning system (GPS)

GPS is a system that determines details like the position, time, path etc., of objects on earth using satellites. Climatic changes never affect their functioning. This system is highly useful for various things from defence, industries to the common man. This facility is available absolutely free to people all over the world. IRNSS (Indian Regional Navigation Satellite System) is an Indian made GPS out of which four satellites have already been launched. We will become self- sufficient with the launch of three more satellites.

Fig. 7.22

## E- wastes

The mercury in electrical and electronic appliances and the poisonous gases emerging while burning condensers, PCB etc., in incinerators highly pollute the air.

When the e - wastes get mixed with the earth, dangerous chemicals like dioxins, acids, mercury, furans etc., produce highly harmful effects on earth and hence in water.

Even in developed countries the recycling and discard of e - wastes causes major health hazards for the labourers. Such harmful e - wastes should be handled with utmost caution.

## Control of E - waste

Observe Fig 7.22.

Where do you dump the parts of old or obsolete computers? To which category do these parts belong? Write them down.

- Plastic
- 

There are many substances which produce harmful effects.

Through a project work, find out the harmful substances which are contained in e - wastes in your school.

What a large quantity of e - wastes are being accumulated in your school in a year!

What about the quantity of e - wastes accumulated in your district and your state?

How do you discard used up CFL, mercury vapor lamp etc., at your home? Are you simply throwing it away or are you processing it carefully? Don't you feel that you are to be more cautious?

- What are the social and environmental challenges raised by defunct electric and electronic devices?
- Why do we say that e - wastes are to be handled carefully?

With the help of data collected from your locality, present the seriousness of the threat posed by e-wastes.

We have to ensure that modern technology is used for the benefit of the society. It is the mission of the new generation to make sure that it does not have any after effects that may harm mankind.

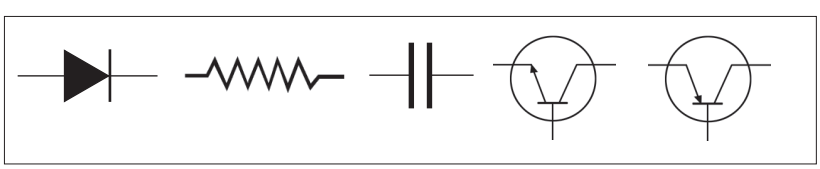
## Significant Learning Outcomes

*The learner can*

- explain the relation between science and technology and present it.
- make use of the advantages of technology in daily life.
- tabulate electronic devices by distinguishing them, know the components in them and present the symbols by tabulating them.
- arrange and operate diode/LED in forward bias as well as reverse bias, explain the differences and depict the circuits.
- arrange and operate diode in AC circuits, and recognize what half wave rectification and full wave rectification are and draw their graphs.
- identify the structural differences between diodes and transistors and present them.
- describe the characteristics of IC chips.
- explain the scopes of photonics, nanotechnology etc., which are different fields of modern technology.
- explain the environmental problems passed by e-wastes and engage in activities for creating awareness about them.

## Let us assess

1.

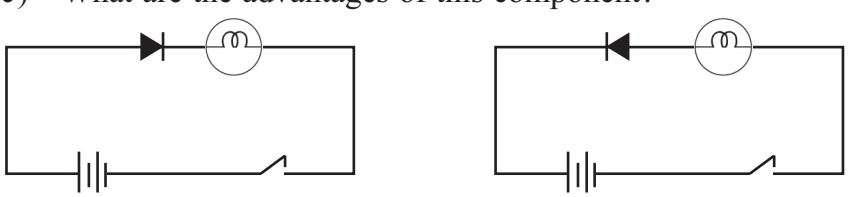


a) Identify the components depicted here and write them down.

b) Which is the electronic component that does the function of all these components?

c) What are the advantages of this component?

2.



(i) In which circuit will the lamp glow when switched on?

(ii) What is the function of a diode?

3. Write down any four situations in which nanotechnology can be made use of.
4. Prepare a short note on the environmental problems caused by e -wastes.

## *Extended activities*

1. Dismantle a defunct radio and try to understand its various parts.
2. Construct a full wave rectifier that can give 6 V DC and operate it.
3. Collect electronic components and conduct an exhibition.
4. Present a seminar paper on the topic ‘Growth in the field of telecommunication'.
5. Collect the details of different types of robots and exhibit them on a bulletin board.

# 8 Energy management


Is it not about the need for encouraging public transportation that the boy is referring to? What is your opinion?

Observe the Fig. 8.1 given below.

You can see the systems used for travel as well as the movement of goods. How much they have changed!

Fig 8.1

Write down the changes happening around us now.

- Transportation of goods through motor vehicles
- Travel facilities from motor cycle to aeroplane
- Multi storied buildings
- Business centres
- Increase in population
-

Note down the changes that have taken place in the different fields - in the periods mentioned above and compare them. Can't you guess what a big increase there has been in energy consumption due to these changes?

On the basis of your findings, what is your inference regarding the energy consumption per head in the modern times?

Along with the human progress, the speed of travel and the housing facilities had also increased. Accordingly we had to increase the facilities for industries and allied fields.

In the context of enhanced need for energy, shouldn't we take measures to see that energy is not wasted and that other related issues are also solved?

## Fuels

Fuels are substances that release plenty of heat energy on burning.

Aren't we using fuels for different purposes including cooking food? Which are the substances used as fuel?

Classify them into solids, liquids and gases, and tabulate.

| Solid | Liquid | Gas |
|---|---|---|
| • Firewood<br>• | • Kerosene<br>• | • Biogas<br>• |

Table 8.1

- Haven't you seen people blowing air into the oven when the firewood is burning? Why does the flame flare up on blowing?

Let's do an experiment. Take two papers of similar size. Crumble one of them and keep the other flat. Attach each to the mid rib of a coconut leaf and burn both. What difference do you see in their burning?

| Crumbled paper | Flat paper |
|---|---|
| • A lot of soot | |

Table 8.2

- What may be the reason behind the difference in their combustion? Write down the answer in relation to the blowing of air into the oven.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

- What are the conditions favourable for the complete combustion of different fuels?
  - The solid fuels must be dry.
  - Should evaporate easily.
  - Should reach the ignition temperature.
- What are the reasons for partial combustion?

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

- What are the drawbacks of partial combustion? Expand the list.
  - Loss of fuel
  - Loss of time
  -
- You have learnt about the products of combustion. Try to write them down.
  - Carbon dioxide
  -
- What are the advantages of using smokeless oven at home?

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

- Haven't you seen pollution testing centres? Why is the test done on vehicles?

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Visit a nearby pollution testing centre, interact with the staff there and prepare a note on pollution testing.

### Combustion of fuels

Fuels burn with the help of oxygen. Generally, complete combustion is a reaction in which fuels react intensively with oxygen, producing carbon dioxide, steam, heat and light. If sufficient oxygen is not available the rate of combustion decreases. If oxygen is not sufficient large quantities of carbon monoxide, soot and a little of carbon dioxide will be formed. This type of burning is partial combustion. Haven't you learnt about the problems caused when carbon monoxide mixes with atmospheric air? Pollution test is conducted to know the components in the gases released from the vehicle exceed the permitted limits.

The problem created by the excessive exhaust gas released by lakhs of vehicles in each second is a burning problem. Aren't you now convinced about the need for making pollution testing mandatory?

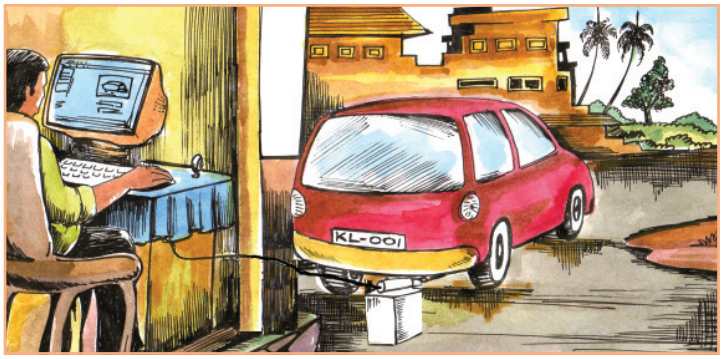


Fig 8.2

Partial combustion causes atmospheric pollution as well.

Write down instances of atmospheric pollution by combustion from sources other than home and vehicles.

## Fossil fuels

Observe the figure drawn by a child during a drawing competition conducted in connection with energy conservation. Conduct a discussion in the class about such a situation as shown in Fig 8.3. What are your responses?

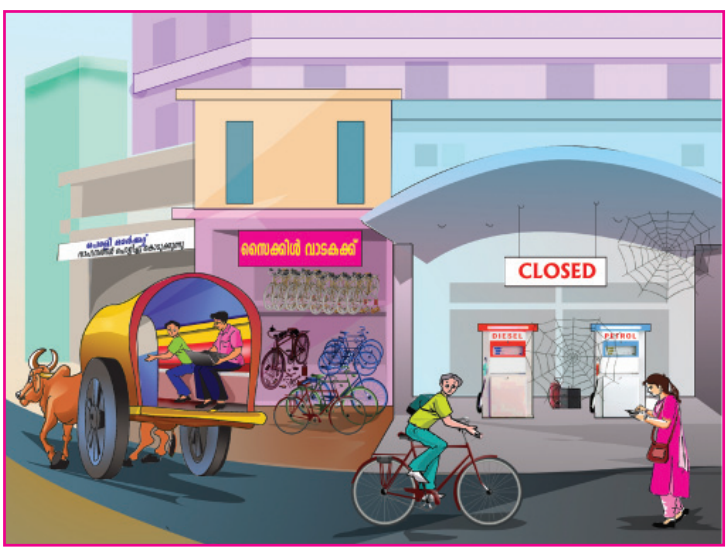


Fig 8.3

- Why have we reached such a situation?
- Which are the fuels used in vehicles nowadays?

Which are the situations, other than home and vehicles, in which fuels are essential? Which are the fuels needed for each? Write them down.

- Record the source of each fuel you have listed.
  - Diesel, LPG → Petroleum
  -

### Fossil fuels

Fossil fuels are formed by the transformation of plants and animals that went under the earth's crust millions of years ago. The transformation took place in the absence of air, under high pressure and high temperature. Coal, petroleum and natural gases are fossil fuels. They are not replenished or renewed in proportion to their consumption. Hence they are also known as non renewable fuels.

- From where do we get petroleum?

Haven't you studied about the products that can be obtained during fractional distillation of petroleum?

Why do we say that it is essential to control the mining and use of fossil fuels?

### CNG, LNG, LPG

We make liquefied natural gas (LNG) and compressed natural gas (CNG) from the natural gas obtained along with petroleum. The main component of all these is methane. These are used as fuels in vehicles, industries and thermal power stations. The importance of LNG is that natural gas can be liquefied and transported to long distances conveniently. It can again be converted into gaseous form at atmospheric temperature and distributed through pipe lines.

The full form of LPG is liquefied petroleum gas. This is a colourless, odourless gas obtained by the fractional distillation of petroleum. Domestic LPG produces an odour since ethyl mercaptan is added as an indicator to detect gas leakage. The main constituent of LPG is butane.

- In major cities CNG is used as fuel in many vehicles. What are the advantages of using CNG and LNG as fuels instead of petrol and diesel?
  - Low atmospheric pollution
  - High energy efficiency
  - Less expensive
  -
  -
- Which is the gas contained in cylinders supplied for domestic use?

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- Which constituent helps us in identifying the leak of LPG?

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- What is the advantage of knowing the leakage in LPG?

  Find out more details regarding CNG, LNG and LPG and write them down.

| CNG | LNG | LPG |
|---|---|---|
| Methane | Methane | Butane |
| | | |
| | | |

Table 8.3

## Coal

*Coal is the most abundant fossil fuel in the earth. The main component of coal is carbon. Based on the carbon content , it is classified into four groups as peat, lignite, anthracite and bituminous coal. When coal is distilled in the absence of air, the substances obtained are ammonia, coal gas, coal tar and coke.*

- Why is coal called fossil fuel?

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- Which are the gaseous products obtained when coal is distilled?

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Based on the knowledge you have acquired about fossil fuels, record your response to the conversation in the picture.

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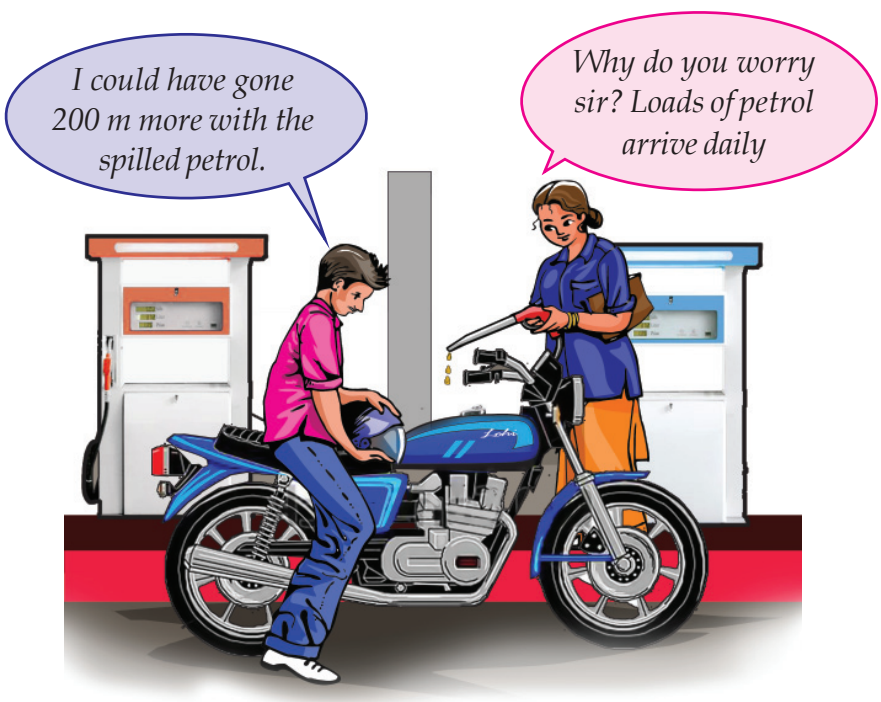


Fig 8.4

Don't you feel that fossil fuels should be preserved for future generations? Prepare some posters to show that fossil fuels are invaluable and that they are to be used judiciously. Display them in your school campus.

We have come across different types of fuels. Is the amount of heat obtained from different fuels the same on burning? Let's see.

## Fuel efficiency

What are the different fuels used at home? Note them down.

Is the heat released from each of them the same when burnt? Let's examine.

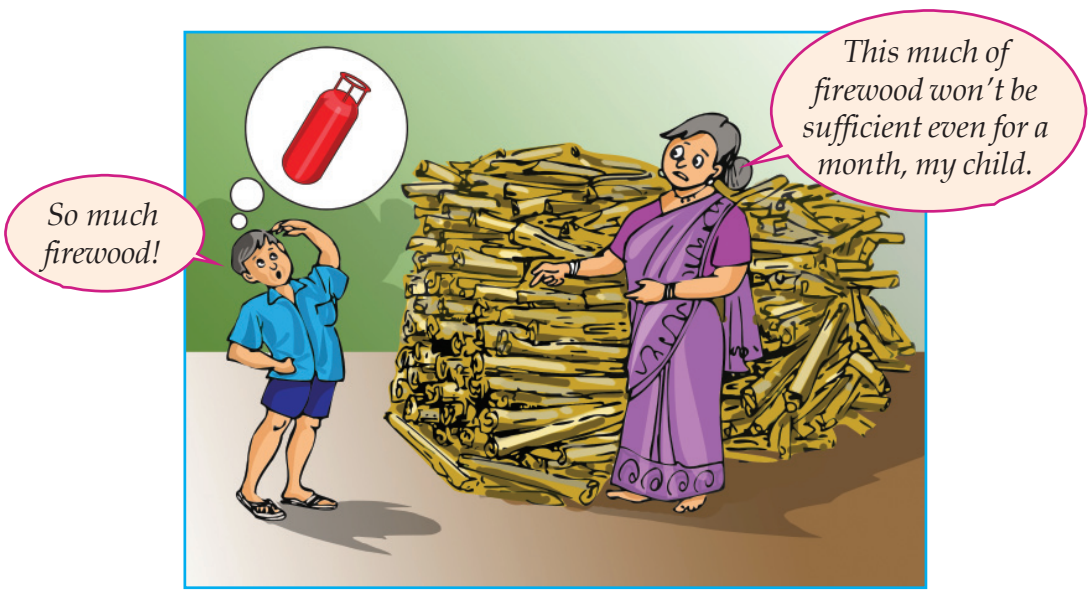


Fig 8.5

- Some of you may be using LPG in your houses. What is the weight of the LPG filled in the cylinders supplied to your homes?

  - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

- For how many days can you cook with this much of fuel?

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- How many days can you cook if you use firewood of the same weight?

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- What difference do you feel in the efficiency of these two fuels?

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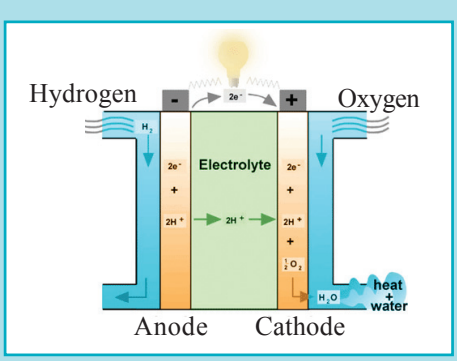
## Hydrogen fuel cell

In the hydrogen fuel cell, hydrogen is filled in one chamber and oxygen in the other. In the middle region, an electrolyte is stored. The catalyst platinum powder ionizes hydrogen. Ions alone can enter an electrolyte. Hence electrons reach the external circuit through conducting wire and then to the oxygen chamber. The atom in the oxygen chamber receives these electrons and gets ionized in the presence of the catalyst nickel which is in nanofilter form. Hydrogen ions and oxygen ions combine with each other in the electrolyte and change into water. The electron flow which takes place along with this is the current. The potential difference of such cells varies from 0.6 V to 0.7 V. Nowadays there are cars, submarines etc., which work on hydrogen fuel cell.




## Calorific value

The amount of heat liberated by the complete combustion of 1 kg of fuel is its calorific value. Its unit is kilojoule/kilogram.

Some fuels and their calorific values:

| | |
|---|---|
| *Hydrogen* | – *150000 kJ/kg* |
| *CNG* | - *50000 kJ/kg* |
| *Dried cow dung* | – *6000 – 8000 kJ/kg* |
| *LPG* | – *55000 kJ/kg* |
| *Biogas* | – *30000 – 40000 kJ/kg* |
| *Coal* | – *25000 – 33000 kJ/kg* |
| *Petrol* | – *45000 kJ/kg* |
| *Methane* | – *50000 kJ/kg* |

- Which fuel can be considered as the most efficient, based on the calorific value?

---

## Hydrogen and hydrogen fuel cell

*Hydrogen is the fuel with highest calorific value. This is a highly inflammable and explosive substance. So it is difficult to store and transport it. We make use of hydrogen fuel cell to produce electricity by combining hydrogen and oxygen. Such cells are similar to ordinary cell.*

- Which are the instances where hydrogen is used as fuel?

---

- Why is hydrogen not used as a domestic fuel?

---

Now you know about different types of fuels and their calorific values. What are the properties that a good fuel must have? Add them to the list.

- Should be easily available.
- Should be of low cost.
- Should cause minimum atmospheric pollution on combustion.

- A liquid fuel must not evaporate quickly at ordinary temperatures.
-

## Biomass

We have been using firewood, dried cow dung etc., as fuel from ancient times. Since these fuels are obtained from plants and animals, these are known as bio waste or biomass. Aren't we using different bio wastes for different purposes? What are the problems that arise due to their combustion? Write them down.

- Smoke is formed
-

*The body parts of plants and animals are known as biomass.*

Haven't you seen solid waste heaped in public places? Don't you experience a putrid smell, when you pass them? Which are the gases responsible for this smell?

---

What are the problems that may arise when gases like hydrogen sulphide, methane etc., spread in the atmosphere?

Discuss and record.

Besides air pollution, what are the problems that may arise when garbage is heaped up?

## Biogas

*When domestic waste is deposited into a biogas plant, biogas is formed by the action of bacteria in the absence of oxygen. Its main constituent is methane. The slurry discharged from the plant is good manure. When biomass is converted into biogas not only a fuel of greater calorific value is obtained but the atmospheric pollution is also minimised.*

Fig 8.6

Discuss the need for community biogas plants and prepare a note.

Nobody realises that the waste we throw indiscreetly on the wayside beckons contagious diseases. Though we are in the forefront regarding individual hygiene, we are far behind in community hygiene. Organise a seminar in your PTA, describing the advantages of the effective utilization of domestic garbages.

How many activities are we engaged in every day! From where does the body get the required energy?

Food is obtained from plants.

- From where do plants get the energy for preparing their food?

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

- What are the different forms of energy we get from the sun?

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Attempts to utilise solar energy to its maximum are in progress. What are the devices used for this? Discuss and expand the list.

- Solar panel
- Solar water heater.
-

**Sun an endless source of energy**

About 30% of the solar energy reaching the earth gets reflected. The rest is absorbed by clouds, ocean and earth. The energy thus absorbed in one hour is much greater than the energy needed for us in one full year.

## Electrical energy from solar energy

Solar cell is a means for converting solar energy into electrical energy. This is a p-n junction diode. When solar energy falls on n side of a solar cell, a small electric current is obtained due to the flow of electrons to p region from n region. This phenomenon is the photovoltaic effect. The electrical energy thus obtained is stored in batteries and used as and when required.

## Solar panel

*The voltage and current obtained from a solar cell is insignificant. A large number of solar cells are suitably assembled to form a solar panel. The electric current obtained from a large number of such cells can be stored in a battery and used as and when it is needed. Solar panel is used extensively in lighting street lamps. They are used to meet the energy requirement of artificial satellites. Nowadays solar photo voltaic (SPV) power plants capable of producing electricity of thousands of kilowatt are in use.*

Solar panel installed at Nedumpassery Airport
Fig 8.7

- What is the energy transformation taking place in a solar cell?

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

- There are certain situations in which solar panel cannot be put to use. Which are they?

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

- What are the situations where solar panel alone is depended on?

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Will it not be possible to solve the energy crisis to some extent if the excess of electrical energy obtained from the solar panel is transferred to the power grid? This method has been implemented successfully at Nedumbassery airport (Cochin International Air Port).

## Heat energy from solar energy

Solar water heater, solar cooker etc., are devices that make direct use of solar heat radiations. Hot water required for hospitals and hotels and for cooking food, washing vessels in houses etc., can be produced using solar water heater. A lot of energy can be saved in this way.

Observe the illustration of the structure of a solar water heater.

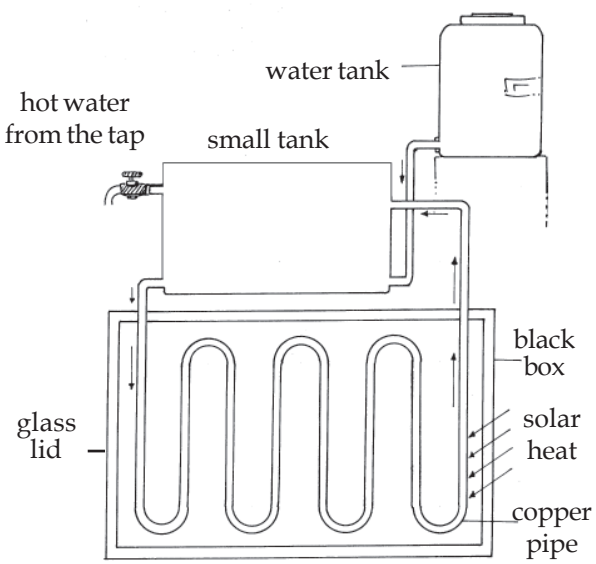



**Illustration of the functioning of a solar water heater**

Fig 8.8

### ANERT

ANERT *(Agency for Non conventional Energies and Rural Technology)* is the nodal agency for creating public awareness about renewable sources of energy and devices that make use of them. It is ANERT that is electrifying isolated places, installing street lamps that work making use of wind energy, solar energy etc., and fixing solar fences to protect us from wild animals. In this way it has been possible to find a solution to energy crisis to a certain extent and to spread the concept of green energy to the public. When the plan of placing solar panel on the roof of houses, to produce 3-4 units of electrical energy daily per house is executed in 10000 houses, we can produce electricity which is equal to the energy produced from a power station of 10 megawatt capacity.

Solar water heater

Solar cooker

- What change occurs in the density of water when the temperature increases?

- How does the change in the density facilitate the flow of water through pipes? Discuss and record.
- Hot water comes through the tap placed at the top of the small tank. Why?

Write down the function of solar water heater in your science diary.

Fig 8.9

## Solar thermal power plant

Solar thermal power plant generate electricity using solar energy. Concave reflectors are used to focus the sun's rays on blackened pipes filled with water. As a result, water boils and vaporises. The steam rotates the steam turbine, so that the generator attached to the turbine is activated. A power plant of this type operates at Gurgaon in Haryana on an experimental basis. The capacity of this plant is 500 kilowatt.

- What is the energy transformation that takes place in solar power plants?

We are now familiar with certain devices which directly make use of solar energy. Isn't the sun behind almost all the phenomena on earth such as wind, waves etc? Hence the sun can be considered as the source of energy for these. In olden days the wind was used in yachts for transportation. But now the wind is used for generating electricity.

### Windmills in Kerala

The windmill owned by the Kerala Government is set up and is being operated at Kanjikode in Palakkad district where there are strong winds most of the time in an year. The Electricity Board has set up a few windmills in Ramakkalmedu which can generate about 750 kW power.

Fig 8.10

## Windmills

- For what purposes can the energy from windmills be utilised?

- What are the factors to be considered while selecting land for a wind farm?

- Where are the wind farms in Kerala set up?

## Nuclear energy

Take a look at the newspaper report carefully.

Which is the disaster reported in the newspapers?

How was it possible to produce such extremely devastating energy from an atom bomb?

Can't this energy be used for peaceful purposes?

Nuclear fission is the process by which the nuclei of greater mass are split into lighter nuclei, using neutrons. The mass of small nuclei formed is less than that of parent nucleus. It means that there is loss in the mass of matter during such splitting up. The mass which is lost is converted into energy. According to Einstein's equation $E = mc^2$, even if the matter converted is very small, the energy produced will be very large. Uncontrolled fission will end in a big explosion. This is the process that takes place in an atom bomb.

The first atom bomb as destructive as a 20000 tonne TNT!

The first atom bomb exploded in Japan on 6th August 1945. Shower of destruction begins.


San Francisco

Japan Hit By Atom Bomb---Mightiest Weapon in History! Tokyo Admits Heavy Damage

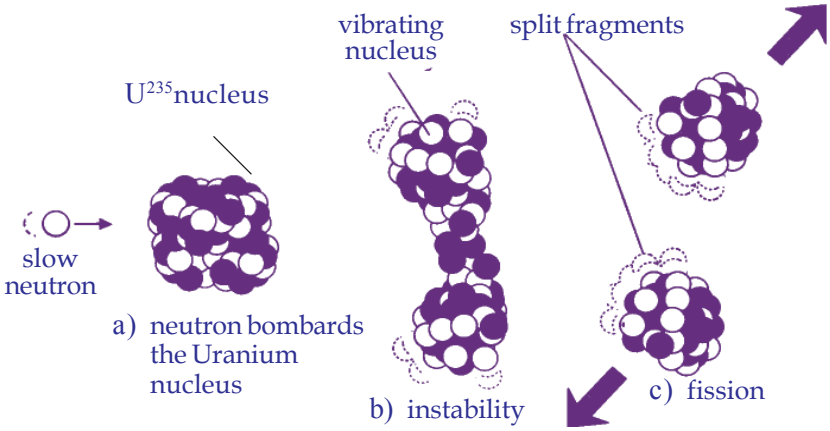
New Epoch in Science, War Single Missile Dropped---More Force Than 2000 B-29 Raid; Capitulation May Be Hastened

'Basic Power of Universe' Harnessed in Secret Tests; Truman Reveals the Story

Multiply This by Two Thousand!

### Einstein and $E = mc^2$

This is the equation for the energy E released when a matter of mass m is converted into energy. c is the velocity of light. Do you know how much energy is produced when 1 kg of matter is converted into energy? $E = 1 \times (3 \times 10^8)^2 = 9 \times 10^{16}$ J. Don't you know that this is a huge quantity?




**The fission of $U^{235}$ nucleus**

Fig 8.11

## Nuclear fusion

*Nuclear fusion is the process in which lighter nuclei are combined to form heavier ones. In this process the matter lost is converted into energy. Haven't you understood that energy is produced in the stars and the sun in this way? This is the principle used for making a hydrogen bomb. The scientific world has not yet been able to produce energy commercially by controlled nuclear fusion.*

- What are the different methods by which energy is produced from the nucleus?

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- Even if the matter converted is very small, the energy produced is very large. What is the reason?

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- What is the reason for an uncontrolled fission reaction ending in an explosion?

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There are power stations that make use of controlled nuclear fission for producing electricity. Such power stations are referred to as nuclear power stations.

*See 'Nuclear Fission' in PhET in the IT @ School Edubuntu.*

*Nuclear reactor is a system that converts nuclear energy into electrical energy.*

Enriched uranium is the fuel used in nuclear reactors. India has developed the indigenous technology of using carbide fuel in nuclear reactors. The power station at Kalpakkam in Tamilnadu makes use of such a reactor.

We have discussed certain sources of energy. Have they been in use from very early days? Enquire. Find out the sources of energy which have been in use conventionally and those that have come into use only recently and tabulate them.

Sources of energy used conventionally are the conventional sources of energy. Others are non conventional sources of energy.

| Conventional energy sources | Non conventional energy sources |
|---|---|
| • Fossil fuels<br>• Biomass<br>• Hydroelectric power<br>• <br>• | • Solar energy<br>• Tidal energy<br>• Nuclear energy<br>• <br>• |

Table 8.4

## Green energy

Green energy is the energy produced from natural sources which does not cause environmental pollution. All the energy produced

from renewable sources belong to this category. The renewable sources like solar energy, wind energy, energy from waves and energy from biomass are considered as green energy. This is also referred to as clean energy.

But the energy produced from nonrenewable sources such as petroleum and coal, and the nuclear energy are named brown energy. These are sources which cause environmental problems including global warming.

Classify the energy from the following sources as green energy and brown energy:

Solar cells, atomic reactors, tidal energy, hydro electric power, diesel engines, windmills, thermal power stations.

### Renewable sources of energy

Renewable sources of energy are those that can be replenished. Renewable sources are naturally occurring ones like rain, sun light, wind, high tide and geo thermal. They do not cause environment pollution. Petroleum, coal, natural gases, nuclear energy etc., are non renewable sources. These are harmful to the nature.

| Green energy | Brown energy |
|---|---|
| | |

Table 8.5

What are the factors to be ensured while constructing a house to use green energy to the maximum extent possible?

- Sufficient sunlight should be available in the rooms during day time.
- Heat, cooling, and air must be available without using electricity.
-

## Energy crisis

We have started using new energy sources besides the conventional ones. Aren't we forced to face load shedding and power cut inspite of all these? What may be the reason?

The main reason for the increase in energy demand is rise in population.

In what all ways has the population explosion affected the consumption of energy? Expand the list.

- Building construction
- Comforts and luxuries
- Food
-

## Loss of energy through water as well

If 1 mL water is lost from a tap in one second then 60 mL water is lost in one minute, 3600 mL (3.6 L) water in one hour and 86.4 L in one day. If so what a loss in one month! How much energy may be lost in this way? Hasn't the energy used to bring water into the tank been also lost?

## LDR (Light Dependent Resistor)

LDR is a variable resistor that works based on the intensity of light. Its resistance changes in accordance with the change in the intensity of light. Its resistance (a few mega ohm) is maximum when it is in the dark and much less when it is kept in light. Based on this we can save energy to a great extent by using street lights only when there is less light. This is made possible by including LDR in a relay circuit.

In day time the resistance of LDR decreases due to the intense light falling on it. Hence current flows through the circuit containing it and as a result the main switch is turned off. If it is dark the resistance of LDR increases very much and current through it ceases. The switch in the main circuit gets switched on and the street lamps start giving light.

Do you know that the increase in consumption of energy is many times greater even for a small increase in population?

Though the need for energy has increased many times the production has not increased sufficiently.

*Energy crisis is the consequence of increasing demand but decreasing availability.*

What can we do for reducing energy crisis as far as possible?

Expand the list.

- Judicious utilisation of energy.
- Maximum utilisation of solar energy.
- Minimising the wastage of water.
- Making use of public transportation as far as possible.
- Construction and beautifying of houses and roads in a scientific manner.
- Controlling of the street lamps with LDR (Light Dependent Resistor).
- Timely repairing of machines.
- Limiting the size of newly constructed buildings.
- Ensuring maximum efficiency of machines used.
- 

The efforts to minimise the energy crisis should start from the kitchen itself.

Don't you know some devices that reduce energy consumption?

- How does a hotbox help to reduce energy consumption?

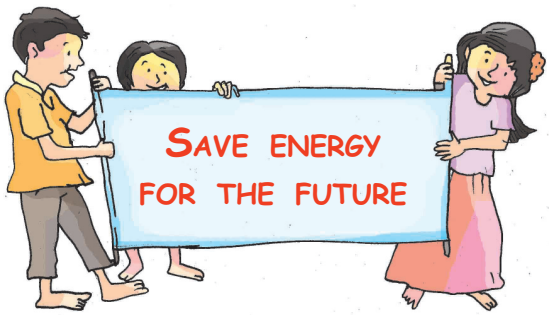
  - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

- What are the different ways by which an energy efficient oven reduces energy consumption? Record.

  - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

- How is it possible to cook food easily by using a pressure cooker? How do we save energy in this way.

Fig 8.12




Be a part of energy conservation by preparing similar posters that can spread social awareness.

## *Significant Learning Outcomes*

*The learner can*

- explain and distinguish between different forms of energy
- explain different kinds of fuels and their efficiency
- explain the possibilities as well as the limitations of hydrogen as a source of fuel in the future.
- explain the availability of non renewable fuels and the control in their uses
- explain how far the renewable sources of energy like biogas, solar energy, wind etc., are useful in minimising the energy crisis.
- find out the causes for energy crisis and find out the methods to reduce it and implement them.
- recognise the renewable sources and make use of them in daily life situations.
- explain how green energy can be used to the maximum level to meet energy requirements effectively.

## *Let us assess*

1. Classify the following sources of energy as renewable and non renewable. Which among them are sources of green energy? Write them down

   - Petroleum
   - coal
   - wind
   - ocean
   - wave
   - hydroelectric power
   - solar energy

2. Explain.
   a) Hydrogen is not used as a household fuel though it is of very high calorific value.
   b) Fossil fuels are to be used judiciously
   c) As far as possible avoid burning of biomass
3. Establish that encouraging the use of green energy is a need of the time.

## Extended activities

1. Find out the scope of hydrogen as a fuel with a high calorific value and prepare an essay
2. Visit a hydroelectric power station and try to understand different stages of the production of electricity. Make use of this principle and find out the scope of mini hydro electric power project.
3. Visit a biogas plant and explore the possibility of establishing a community biogas plant in your region.
4. Write a short play to make the public aware of the need for making use of solar energy.
5. Solar energy has an incredible future in the field of transportation. We are in its infant stage. Write an essay on the topic "Prospects of solar energy"
6. Find out the advantages and disadvantages of main energy sources and tabulate them.

| Serial number | Source of energy | Advantages | Disadvantages |
|---|---|---|---|
| | | | |

7. A nuclear reactor is about to be established in Kerala. What is your reaction to this proposal? Justify.
8. A man pointing at a car running on petrol says, "This car is running on solar energy" Write down your responses about this matter.

## Notes

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