

Science, Technology and Development

Unit 11

After studying this chapter the students will be able to:

- Describe the principle of Lasers and optical fiber system, and describe their functions and uses in different fields with examples.
- Describe the functions and uses of X-rays, ultrasound, ECG, EEG, MRI, CT-scan and angiographies.
- Describe the technologies such as computer, telephone, fax, TV, radio, mobiles used in the modern information age.
- Explain the contribution SUPARCO has made in the development of our country and list its future plans.



INTRODUCTION

Economic growth and well being of a country is directly related to its scientific and industrial advancement. The most advanced countries of the world spend huge amount of money on scientific research. On the other hand, developing countries spend relatively less money on scientific research. As a result, the developing countries heavily depend on the developed countries for the transfer of scientific and technological knowledge. In the present days, science and technology has tremendous influence on our life. From education and health to economic and social development of the society, science and technology plays a key role. In this chapter you will study some of the major technological developments which have significant impacts on our daily life.

11.1 IMPORTANT TECHNOLOGICAL DEVELOPMENTS

Advancement in the field of technology has a direct impact on our daily life. Most of these technological developments have benefitted mankind in the shape of instant communication system, better diagnosis and treatment in the field of medicine, efficient use of information technology in various fields and many more.

Following are some of the important technological developments.

11.1.1 Lasers

Laser stands for "light amplification by stimulated emission of radiation." Laser is a device / source that produce an intense monochromatic and unidirectional coherent beam of visible light. It operates by the principle of stimulated emission of a photon by an atom in excited state.

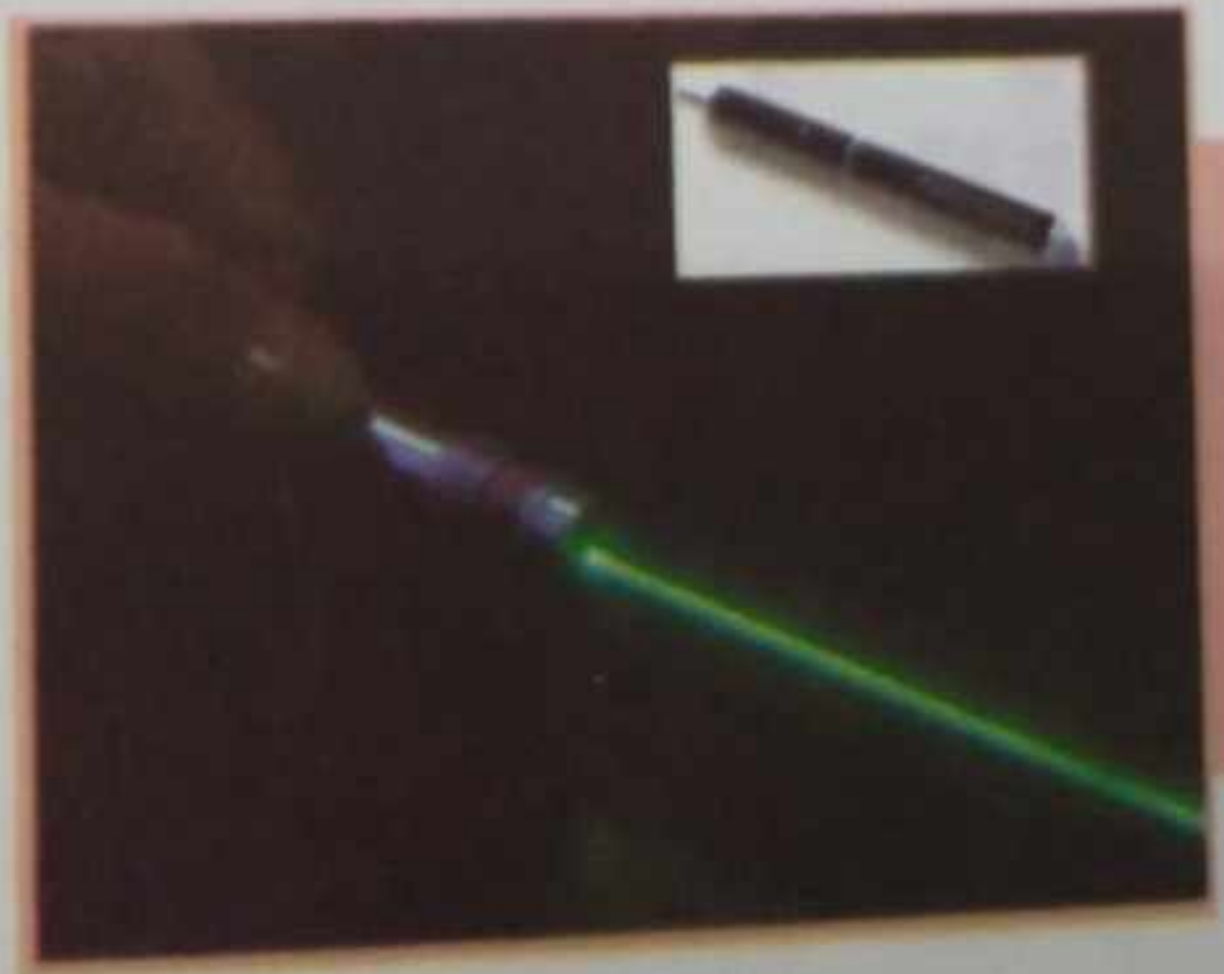


Fig: 11.1 Laser

The light beam produced by most lasers is pencil-sized, and maintains its size and direction over very large distances.

A laser consists of two fundamental parts:

1. An amplifying medium which can be solid, liquid or a gas. It is composed of atoms, molecules, ions or electrons whose energy levels are used to increase the power of a light wave during its propagation.
2. A pumping system: Its function is to excite the amplifying medium which in turn creates a condition for light amplification. For this purpose it supplies critical energy. Pumping systems can be optical, (the sun, flash lamps, tungsten-filament lamps, diode or other lasers), electrical (electric current in semi-conductors, gas discharge tubes) or even chemical.

The different components that make up a basic laser are illustrated in the diagram below.

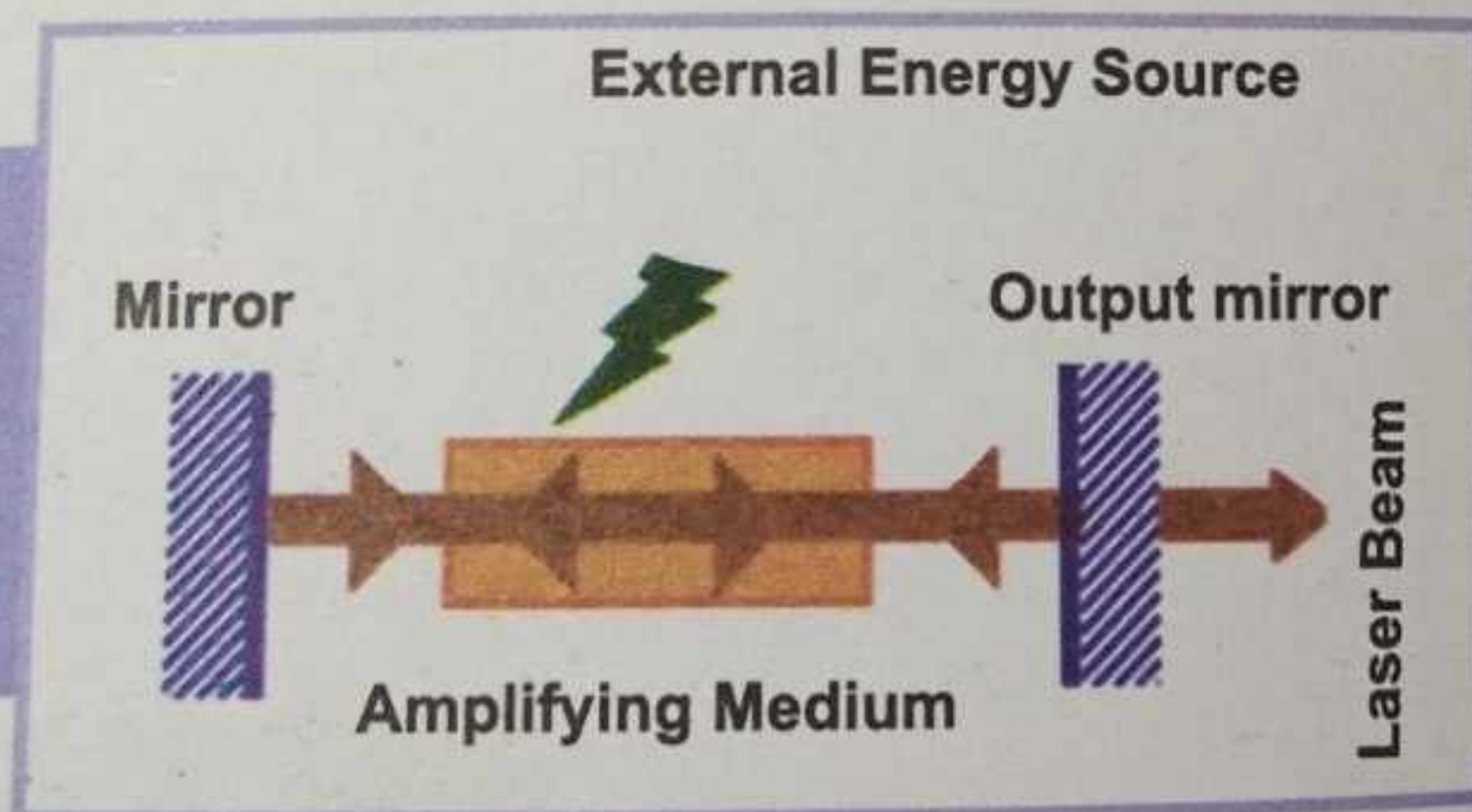


Fig: 11.2 Components of Laser.

ACTIVITY

Take an ordinary torch and a simple laser light device. Use both these devices to throw light on a wall of a dark room from the same distance. Record your observation in your note book.

The fundamental parts of laser amplify light. This is known as a laser amplification. Most of the lasers use a cavity or an optical resonator. Technically, the whole device is known as a laser oscillator which uses reflecting mirrors to amplify the light source considerably by bouncing it back and forth within the cavity.

DO YOU KNOW?

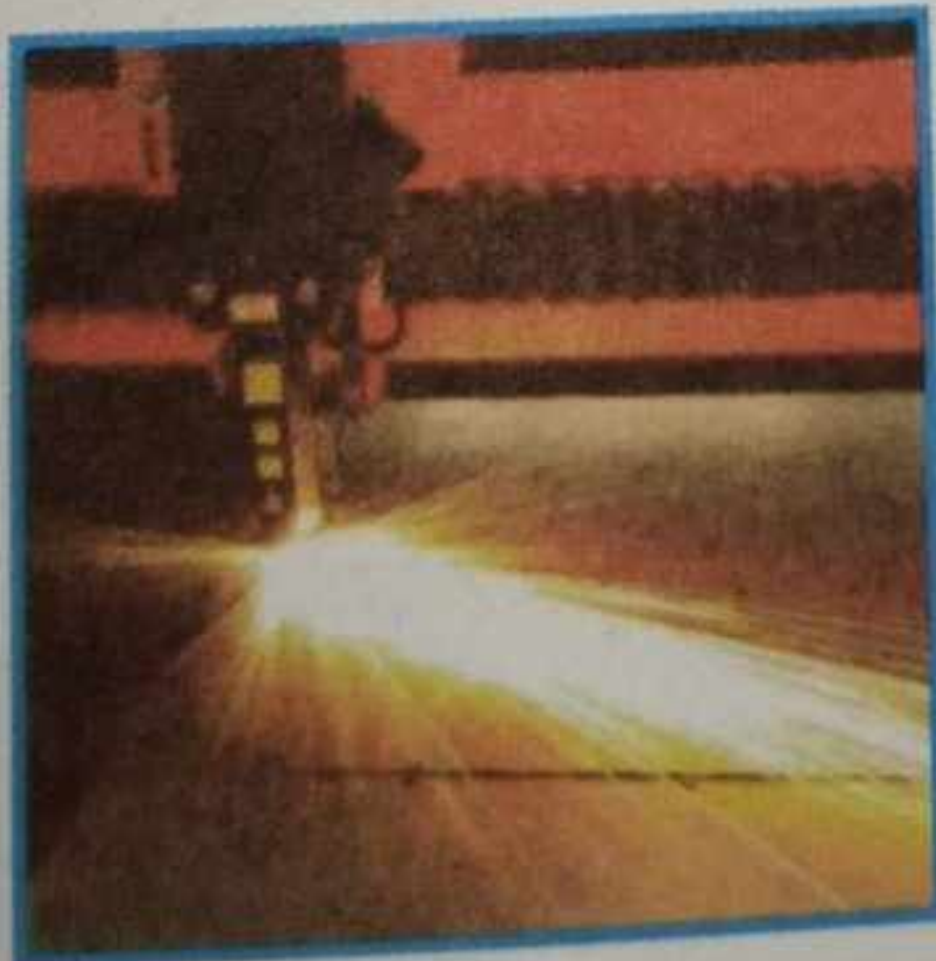
Many useful inventions use lasers. For example, DVD and CD players, bar code readers etc. Metal workers use lasers to cut and weld metal. Likewise workers in clothing factories use lasers to cut through hundreds of layers of fabric at once.



Bar code reader



DVD players use lasers



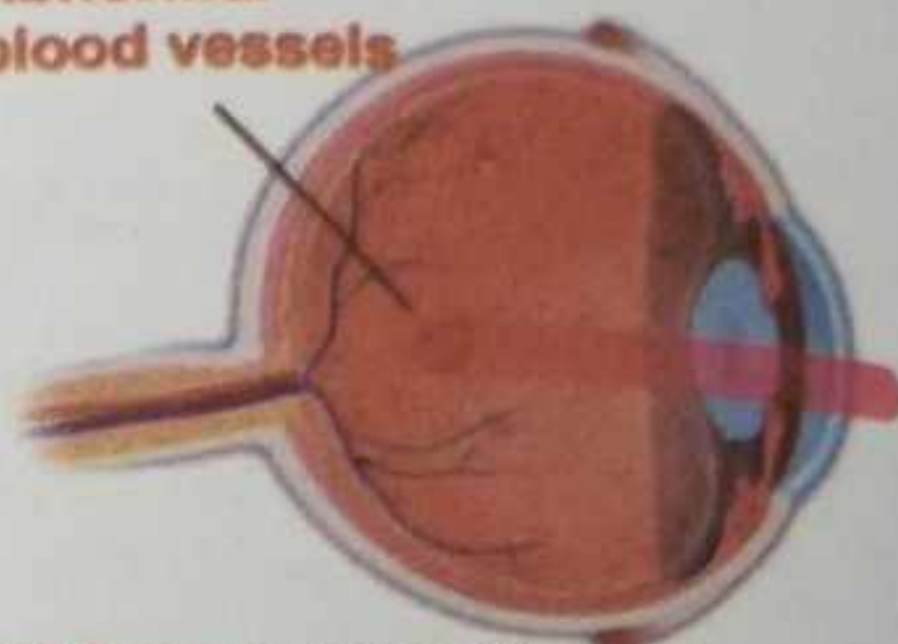
Metal Cut by lasers

Applications of Lasers

Lasers have been used in a number of areas of scientific research, and have opened a new field of scientific research,. Lasers are widely used in many ways. Some of these are described below:

1. Lasers are being used in telecommunications in space and in open-air communications.
2. Lasers are used for microsurgery of different body organs.
3. Lasers are used for bar-code scanners and also in printers for getting superior quality computer print outs.
4. Lasers are used in various industries for different activities like boring and cutting metals and for cutting several layers of fabrics in the textile industry.
5. Laser beam can be used to generate three dimensional image of an object in a process called holography.
6. Lasers are used in different types of weapons like tanks, missiles and bombers to locate the exact position of the enemy.

Abnormal blood vessels



Hot laser causes thermal destruction of abnormal blood vessels



Fig: 11.3 Application of Laser.

11.1.2 Optical Fibers/ Fiber optics

An optical fibre is a very thin, flexible transparent glass or plastic rod. Its surface is coated with another type of transparent material whose refractive index is less than it. This coating not only protects the light but also optically insulates adjacent fibres. The thickness of an optical fibre is nearly equal to that of human hair i.e about one hundredth of a millimetre. A cable of optical fibre consists of 30 optical fibres.

Optical fibres operate on the principle of total internal reflection. When a ray of light enters at one end of an optical fibre, it undergoes total internal reflection off the sides of the fibre until it comes out at the other end as shown in the figure 11.4.

Optical fibres carry digital signals in the form of pulses of light. At the transmitted end, the electrical signals are encoded into light signals by a light emitting diode (LED).

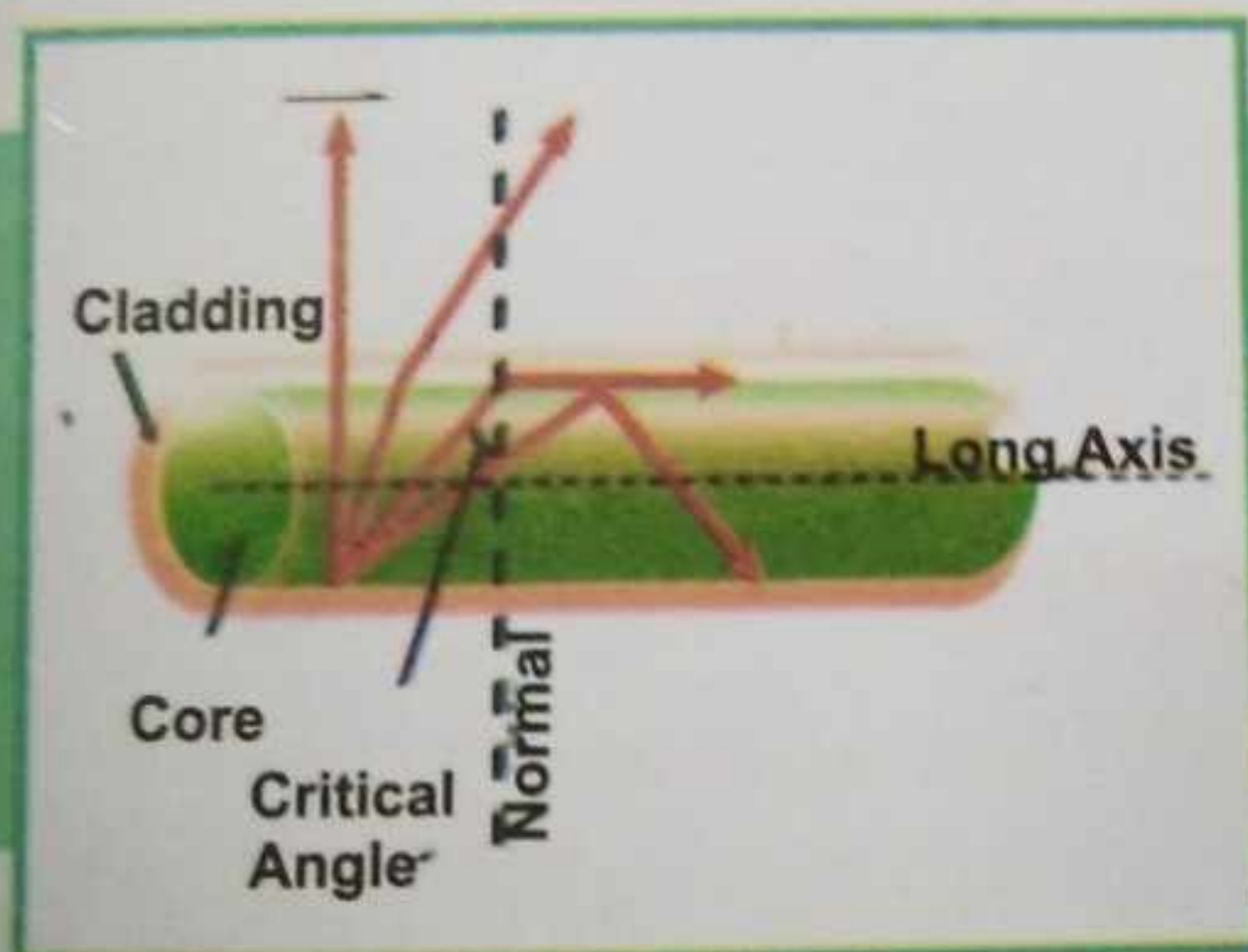


Fig: 11.4 Fiber Optic Internal Reflection.

TADBIT

The amount of energy required to send a flash of light across a distance in fiber optic cables is far less than that required to send electrical signals. Less power means less carbon output, lower emissions and lower prices.

At the receiving end the light signals are decoded by a photodiode which turns them back into electrical signals.

Optical fibres are thinner and lighter than electric cables. They carry more signals than electric cables. They are not affected by electrical interference.

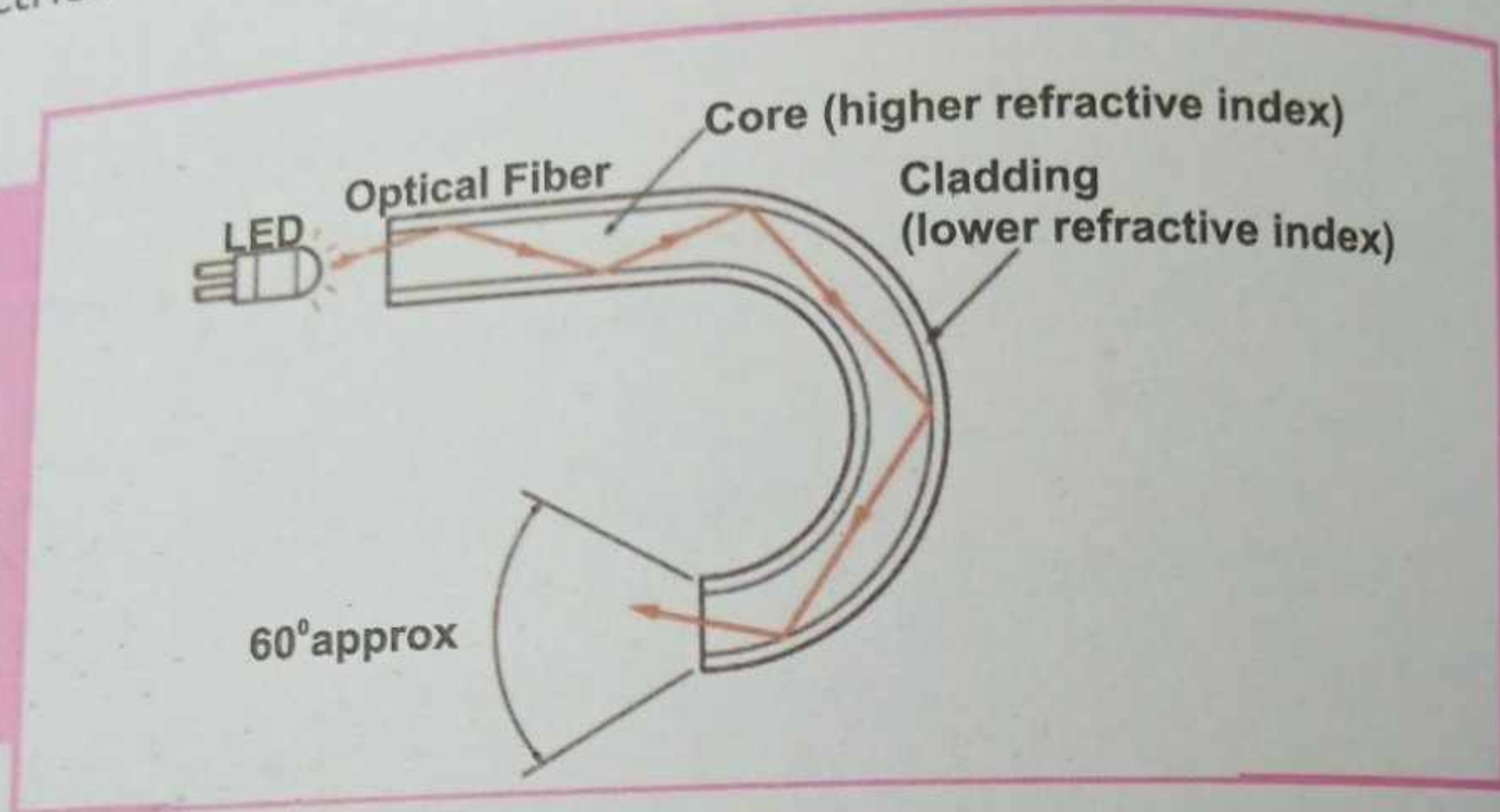


Fig: 11.5 Principle of optical fiber system.

FOR YOUR INFORMATION

Advantages of fiber optics

As compared to copper wire optical cable are less expensive and these can be drawn to smaller diameter. Optical fibers provide a high data transmission rates and higher carrying capacity. Data travels with maximum protection and offers very less losses. Optic fibers are small in size and light in weight. Optic fibers are non flammable and as electric current does not pass through it there is no danger of fire accidents.

Uses

1. Surgeons and physicians often examine the internal organs of the body by obtaining their images on a screen with the help of optical fibres.
2. Optical fibres are used in telephone and other telecommunication systems.
3. These are used in the night vision devices, photo-electronics and automobile panel lighting.

FOR YOUR INFORMATION

Speed: Fiber can carry information so fast that you can transmit three television episodes in one second.

Bandwidth: Taken in bulk, it would take 33 tons of copper to transmit the same amount of information handled by 1/4 pound of optical fiber.

Resistance: Fiber optic cables offer greater resistance to electromagnetic noise such as radios, motors or other nearby cables. Because optical fibers carry beams of light, they are free of electrical noise and interference.

Capacity: Fiber optics have a greater capacity for information which means smaller cables can be used.

FOR YOUR INFORMATION

Optical fibers are used for the transmission of internet data, especially graphical data. They are also used for the transmission of broadband signals, such as high-definition television (HDTV) telecasts. For this reason cable television companies also use fiber for delivery of digital video and data services. Telemedicine devices are used for the transmission of digital diagnostic images used by the doctors to diagnose and treat the patients effectively. Fiber-optic-based telemetry systems are being designed to handle the traffic on busy highways by using intelligent traffic lights, automated tollbooths, changeable message signs etc.



Fig: 11.6 Intelligent traffic lights.

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11.2 Modern Methods of Medical Diagnostics and Treatment

Following are some of the modern methods in medical diagnostics and treatment.

11.2.1 X-Rays

X-rays are electromagnetic radiations, lying between ultraviolet radiations and gamma rays in the spectrum. Their wavelength range is 10^{-11}m to 10^{-8}m . These were discovered by Wilhelm Konrad Rontgen in 1895. X-rays are produced in an apparatus called X-ray tube as shown in the figure: 11.7. An X-ray tube consists of a vacuum tube fitted with cathode and anode which are connected with a high voltage battery. A heavy metal (usually tungsten) is embedded at the anode. When cathode is heated by supplying the current, it emits high energy electrons. These energetic electrons when strike the target at anode, an intense beam of X-rays is produced.

Functions of X-rays

Some of the important functions of X-rays are below:

1. X-rays penetrate several centimeters into solid materials on which they are incident.
2. They cast shadows of the obstacles placed in their path of propagation.

ACTIVITY

Observe under the light an x-ray sheet showing a fractured bone.

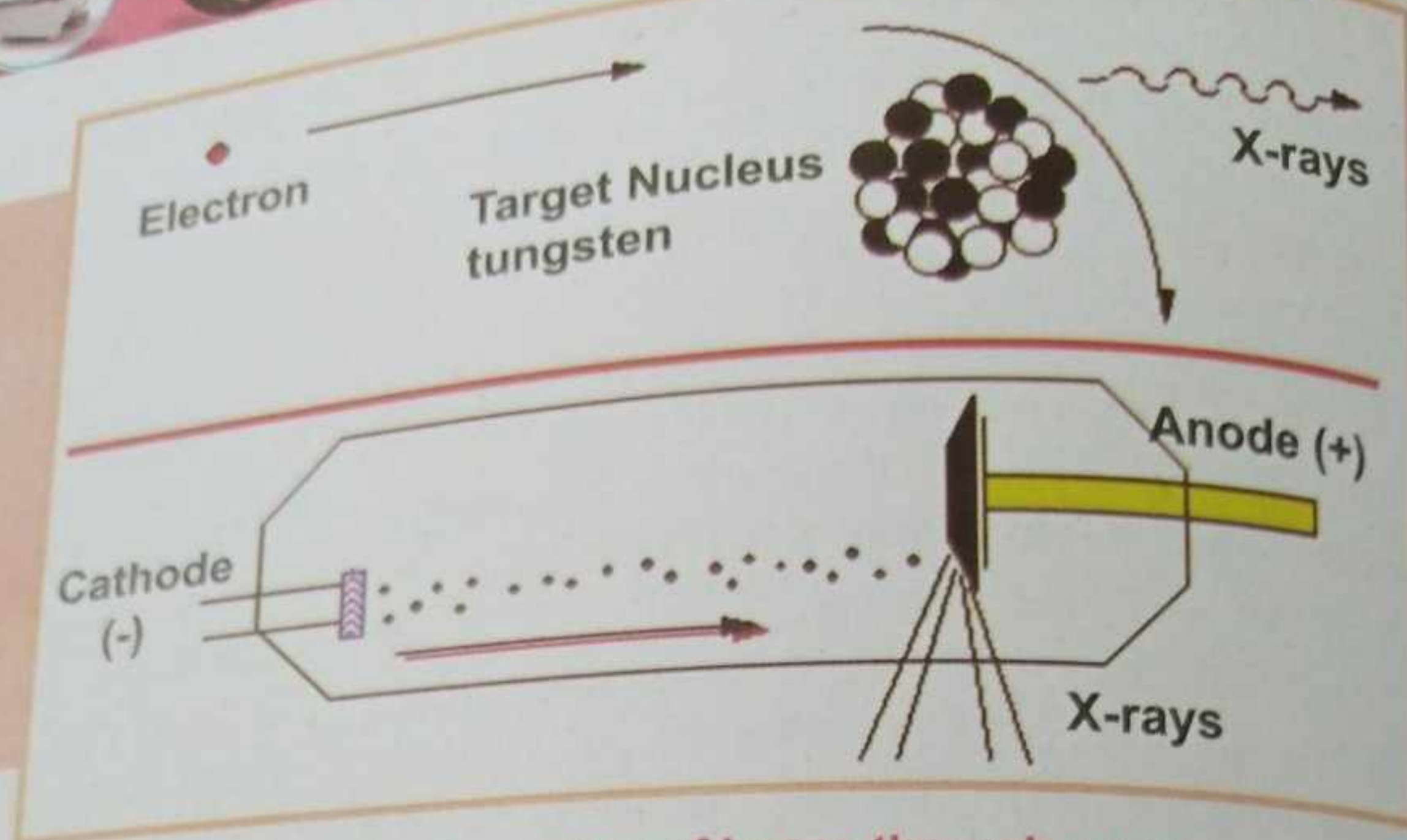


Fig: 11.7 Formation of image through x-rays.

3. They cause florescence in many substances.
4. By passing through solid, liquid or gas, they ionize the atoms.
5. They affect the photographic plates.

Uses of X-rays

Some of the important uses of X-rays are as under:

1. Medical Use: X-rays are used for the diagnostic radiography of bones, chest, kidneys, teeth, etc. to reveal the fractures of bones or abnormality of an organ. X-rays are also used for therapeutic purposes in the treatment of tumors.
2. Industrial Use: X-rays are used to test cracks in structural materials. They are also used to analyze the composition of alloys, structures of rubber and plastics.

- Science, Technology and Environment
3. Safety Use: X-rays are used to look for weapons and bombs in sealed cases at airports.
 4. Scientific Use: X-rays are used to study the crystalline structures of solids.

11.2.2 Ultra Sound

Human ear can respond to a sound having frequencies between 20Hz and 20KHz. The sound frequency less than 20Hz is called infrasonic and higher than 20KHz as ultrasonic. Infrasonic and ultrasonic sound frequencies cannot be heard by human ear but are not less beneficial to mankind. Ultrasonics are widely used waves which are harmless and produce no after effects like x-rays or nuclear radiations. They are longitudinal mechanical waves with frequency above the audible range so these waves have greater penetrating power.

FOR YOUR INFORMATION

Ultrasound technology is a field of increasing application in the areas of food, drug, and device industries. Ultrasonic techniques are presently utilized for applications ranging from bonding and sealing of thermoplastic packaging to medical diagnosis. Other industrial applications of ultrasound include cleaning equipment which utilizes ultrasound to form bubbles in the cleaning or sterilizing liquids. Ultrasonics are also used to form foam in beverage bottles and cans to expel air before closing them.



Ultrasonic leak detector.

Production of Ultrasound Waves

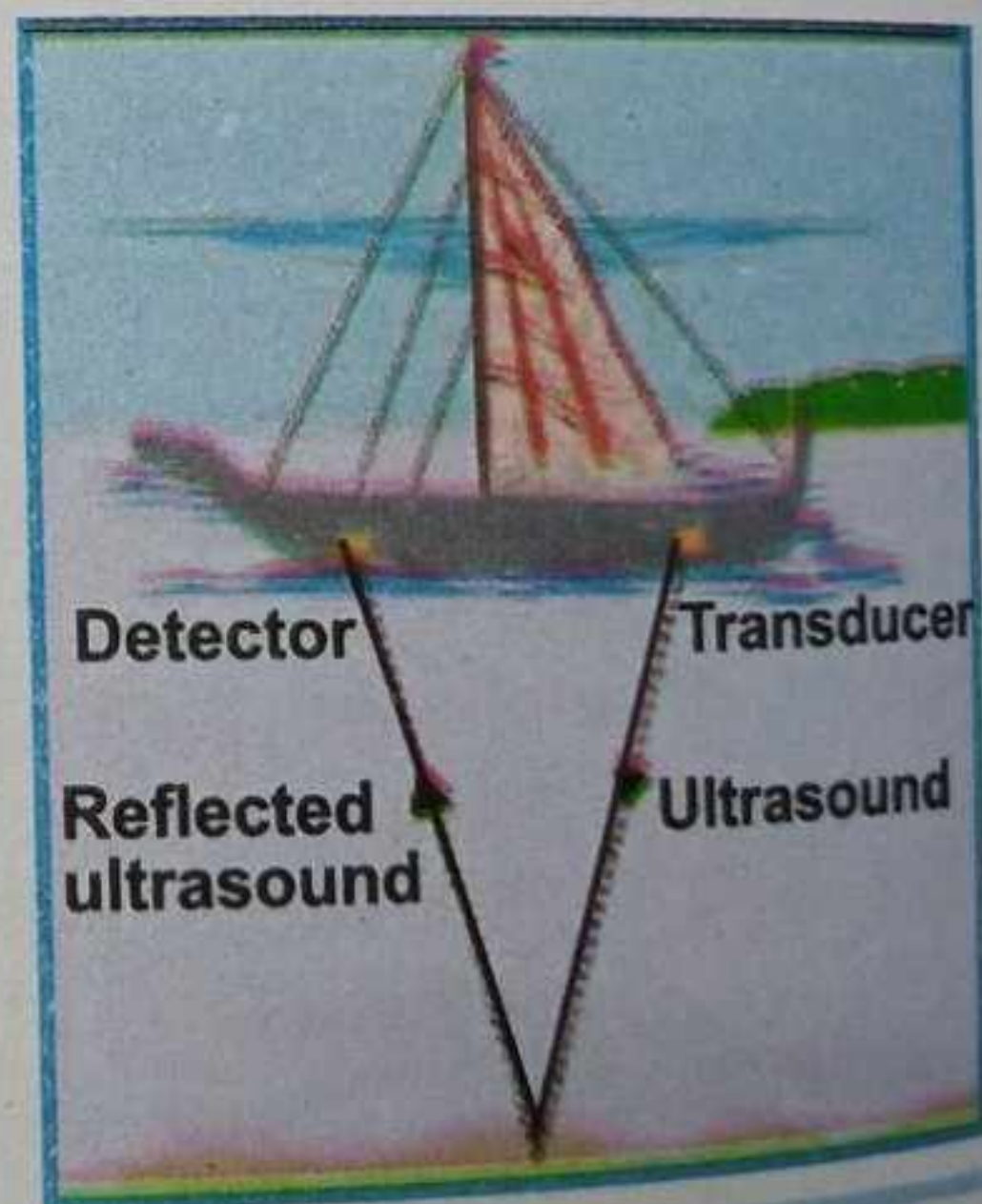
Ultrasound is one of the widely used tools for disease diagnosis and examination of several body parts. The main part of the ultrasound imaging equipment is the transducer. During diagnosis the transducer remain in contact with the surface of the body of the patient. When electrical pulses are supplied to ultrasound machine, the ultrasonic sound is focused by the transducer into small beams which can strike the internal organs. After striking the echo pulse is returned and signals are picked by the transducer and are converted back into electric pulses that are then processed by the system and images are formed.



Fig: 11.8 Ultrasound in diagnosis of diseases.

FOR YOUR INFORMATION

SONAR stands for Sound Navigation and Ranging. This technique is helpful in exploring and mapping the ocean because sound waves travel farther in the water than do radar and light waves. It is primarily used to develop nautical charts, locate underwater hazards to navigation, search for and mapping objects on the sea floor such as shipwrecks, and to map the sea floor itself.



Application of ultrasonic waves

- Ultrasonic waves are widely used as diagnostic, therapeutic, and surgical tools in medicine and industries.

- ii) Ultrasonic waves are also used to obtain cross-sectional pictures of patient's organs in hospital.
- iii) Ultrasonic guidance devices are used for the blind.
- iv) These waves are used to kill bacteria and microorganisms in liquids.
- v) Ultrasonic scans are preferred to x-rays as ultrasound is much safer than x-rays. Ultrasounds are considered best to examine the soft fleshy parts of the body.

11.2.3 EEG (Electroencephalogram)

The electroencephalogram (EEG) is a diagnostic procedure in which electrical activity of the brain is recorded by placing small metal discs called electrodes on the scalp. The recorded waves form pattern show the electrical activity reflected from the cortex of the brain. Cortex is the largest part of the brain which is concerned with the higher functions of the brain such as thought and action.

Brain is composed of nerve cells or neuron which produces electrical signals known as action potentials. From one nerve cell to other, action potential moves through a gap called as synapse with the help of special chemicals known as neurotransmitters.

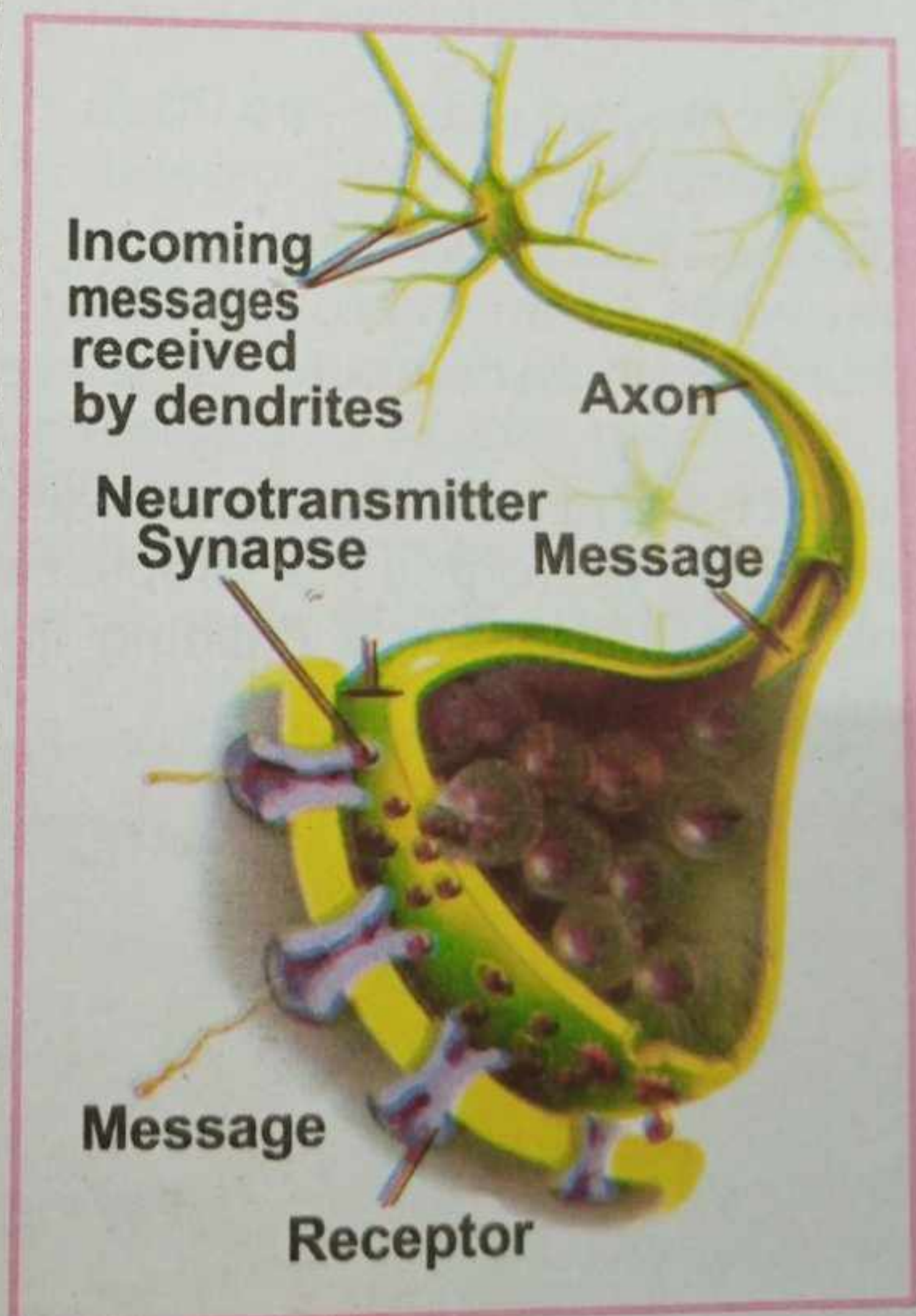


Fig: 11.9 Structure of nerve cell.

Science, Technology and Development

For taking reading of the electrical activity of the brain electrodes are placed on the scalp at specific positions. Each electrode site is labeled with a letter referring to the area of brain underlying the electrode .e.g. T-Temporal lobe and F-Frontal lobe and a number. Even numbers denote the right side of the head and odd numbers the left side of the head.

There is a great variety of electrodes that can be used. Majority are small discs of stainless steel, tin, gold or silver covered with a silver chloride coating. These normally have a lead attached.

Sometimes, an elastic cap fitted with electrodes is used instead.

The electrodes are connected

with wires to an instrument that amplifies the brain waves and records them on computer equipment.

The technician may ask the patient from time to time to open and close eyes, perform a few simple calculations, read a paragraph, to look at a picture or a flashing light, breathe deeply for a few minutes.

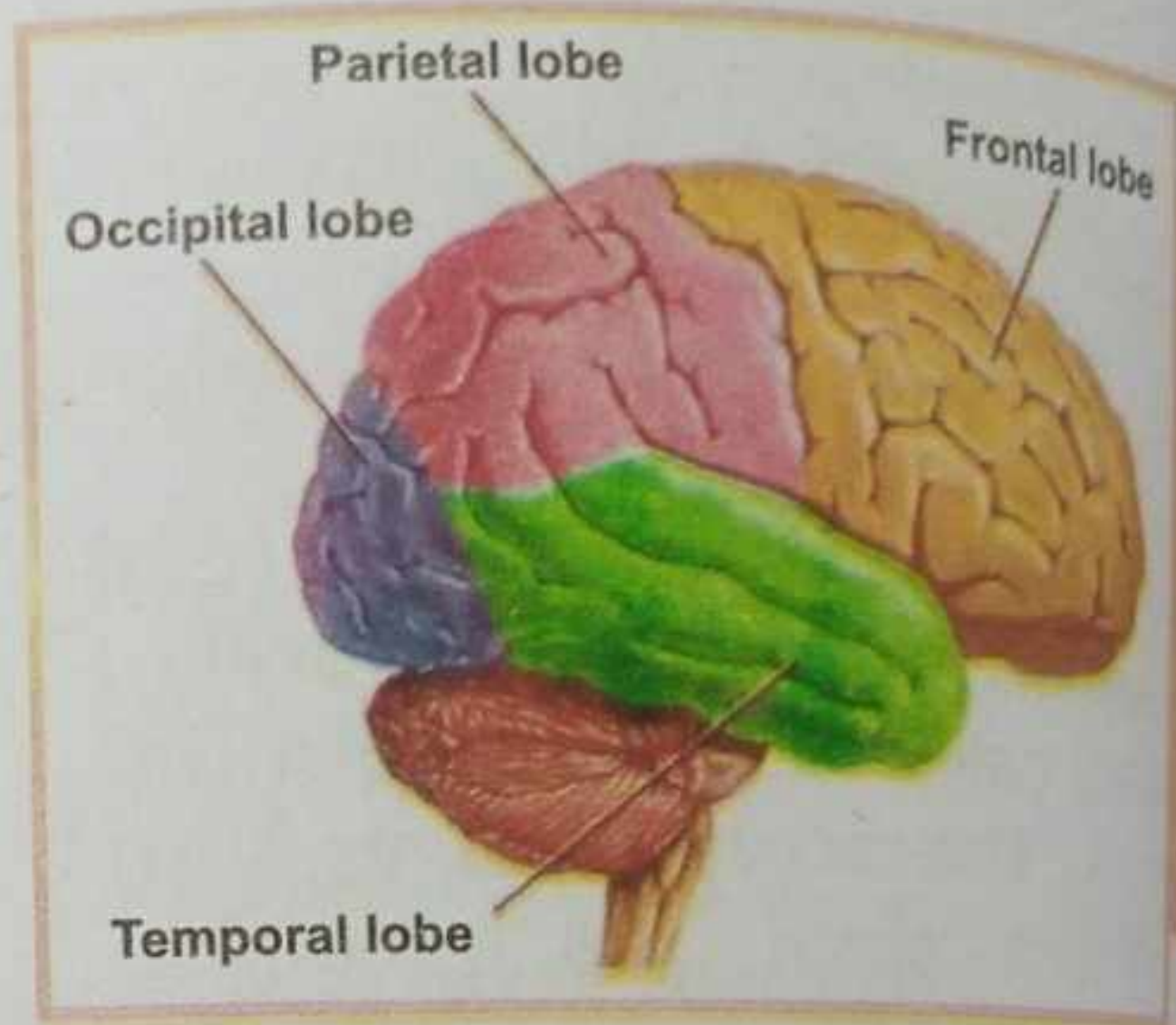


Fig: 11.10 Different lobes of brain.



Fig: 11.11 Electrodes are being attached for test.

Video is frequently recorded during the EEG. Body motions are captured by a video camera while the EEG simultaneously records brain waves. This combined recording may help doctor diagnose and treat a medical problem.

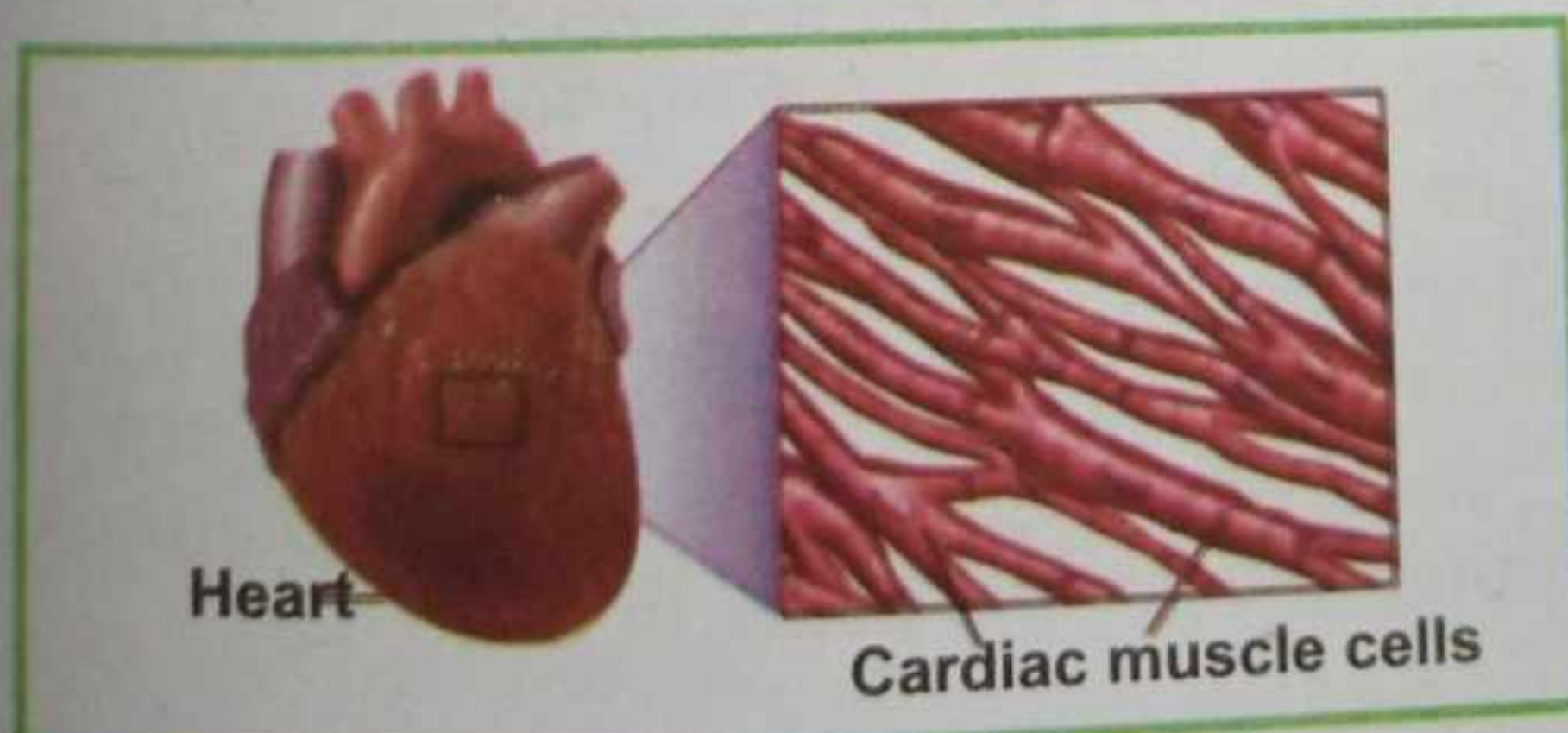
11.2.4 ECG (Electrocardiogram)

An electrocardiogram (ECG) is an electrical recording of the heart and is used in the investigation of heart disease. An electrocardiographic lead is a recording electrode or a pair of recording electrodes at a specified location on the body. In clinical practices, twelve leads are usually used in the diagnostic ECG, although there is no limitation to the number of leads. The leads are usually placed on the elbows and stifles.

The electrocardiography is a technique of recording the bio-electric currents generated by the heart.

FOR YOUR INFORMATION

Cardiac cells at rest are considered as polarized, having no electrical activity. The cell membrane of cardiac muscle cell separates different concentrations of ions such as sodium, potassium, and calcium. This is called the resting potential. Electrical impulses are generated automatically by specialized cardiac cells. Once an electrical cell generates an electrical impulse and ions cross the cell membrane, the resting potential turns into action potential also known as depolarization.



The graphical display of this recording is called electrocardiogram. The ECG, refers in general to both electrocardiogram and electrocardiography. For more than one hundred years, the ECG has been used to reveal the condition of the heart and to diagnose cardiac illnesses. This has been possible because the cardiac muscle cells generate bio-currents which can be detected inside the body or on its surface using some special electrodes. Unlike the bio-currents generated by some other muscles, the currents generated by the heart muscles are periodic, that is, they consist of a repeated sequence of characteristic waveforms which correspond to a heart beat.

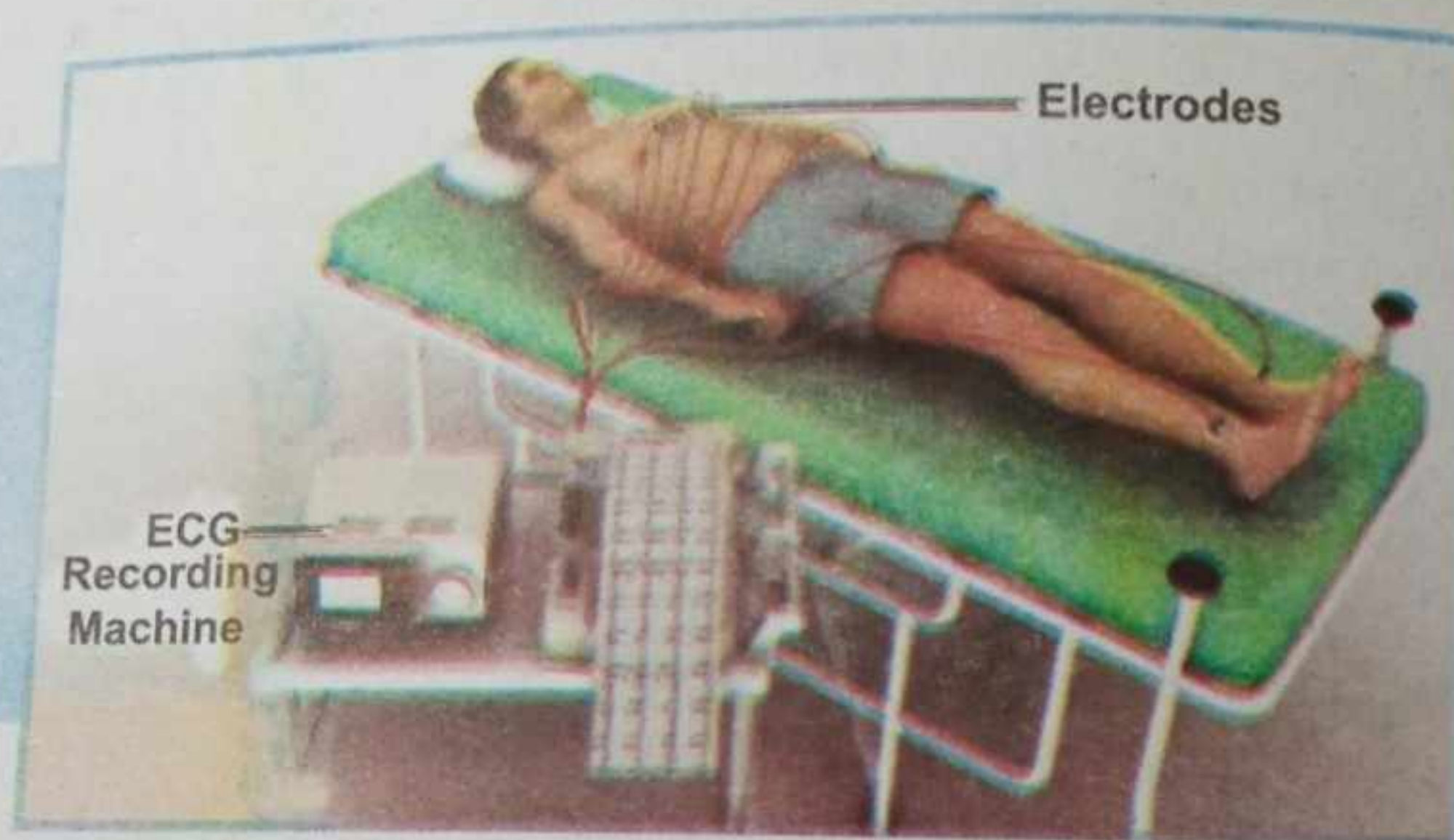


Fig: 11.12 ECG test.

11.2.5 CT SCAN (Computerised tomography)

Computerized tomography scans are special type of x-ray tests that produce cross-sectional images of the body using x-rays and the images are generated in the computer. With the help of computerized tomography scans, small nodules or tumors get detected which are not visible, unnoticed and undetected by x-rays. Such images generally helps doctors to diagnose a certain abnormal condition developing in the body.

Computerised tomography scans are generally used to collect graphical information which can be used to assess the general health of the brain, neck, spine, chest, abdomen, pelvis and sinuses.

Computerised tomography (CT Scan) of the brain

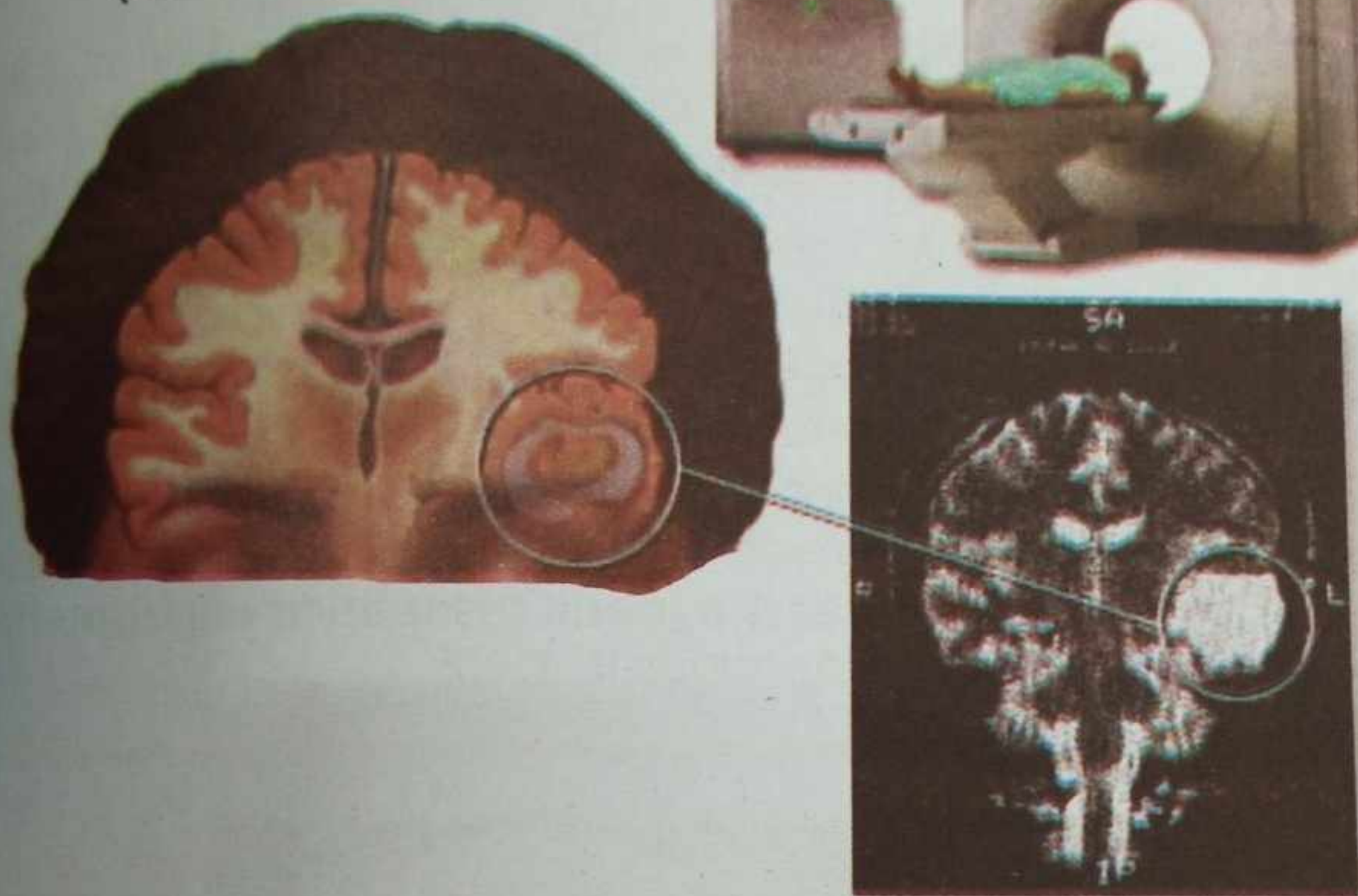


Fig: 11.13 CT scan

One of the advantage of CT scan over other diagnostic procedures is that it is useful in the examination of the soft body tissues like liver, stomach, and some other abdominal organs. It is also being used for the examination of brain to look for a mass, stroke, area of bleeding, or blood vessel abnormality. CT scans are also used as a confirmatory procedure for checking the already known results using X-rays and ultrasound test. CT scan can also be used to see the spread of a cancer in the body.

11.2.6 MRI (Magnetic Resonance Imaging)

Magnetic resonance imaging (MRI) scanners are used to produce two-dimensional and three-dimensional internal images of the body. These scanners work in a similar way like that of CT scan. However, MRI scan does not use X-rays as in CT scan, rather it uses a strong magnetic field and radio waves to produce very clear and detailed images of inside of the body on a computer.

Commonly MRI is used to examine the brain, spinal cord, joints, abdomen, and pelvis. Apart from this, a special kind of MRI called magnetic resonance angiography (MRA) is used to examine the blood vessels.

FOR YOUR INFORMATION

Felix Bloch from Stanford University and Edward Purcell from Harvard University, working independently, performed the first successful nuclear magnetic resonance experiment to study the chemical compounds in 1946.

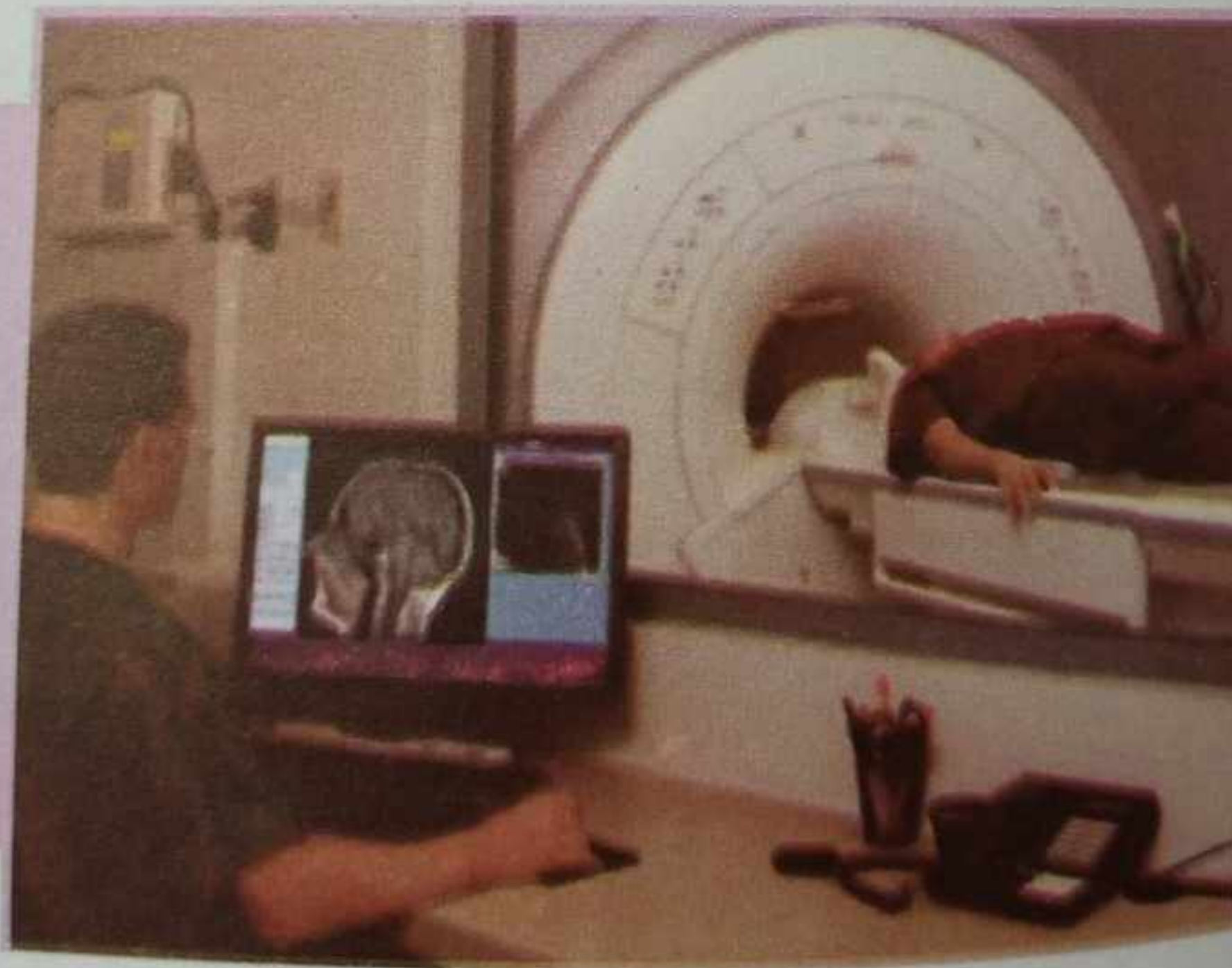
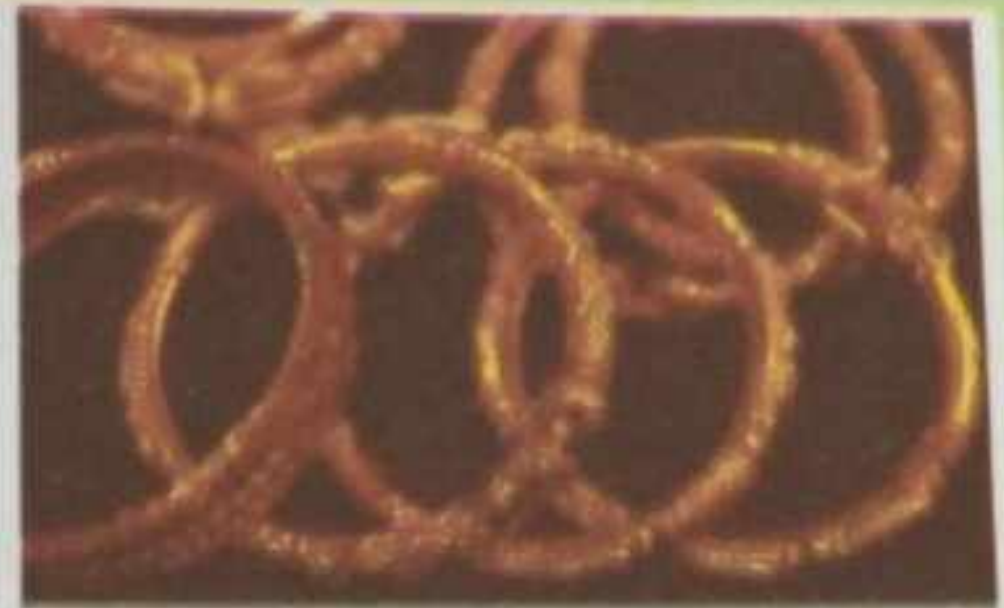


Fig: 11.14 MRI scan

A head coil is placed around the patient's head while examining the MRI of brain. With the help of this head coil diverse images of brain are captured for diagnostic purposes. MRI scans are also used for the diagnosis of medical problems related to hearing, general weakness, blurred vision, seizures etc.

FOR YOUR INFORMATION

During an MRI test, patient is asked to remove all accessories such as jewelry, credit cards, and any metallic objects. The reason for this is that MRIs involve magnets, which may interact with objects. This in turn may lead to bad results and/or poor image quality.



11.2.7 Angiography

Angiography is a diagnostic procedure which detects the general conditions of the blood vessels. It gives an information showing whether blood vessels are narrow, irregular or blocked. It also gives an overview of the blood flow condition in the blood vessels and also detect the development of clumps of new vessels and other abnormal patterns like tumours and injuries. Angiography is also a useful procedure for investigating the narrowing or blockage of the coronary arteries supplying blood to the heart, so that necessary treatment like balloon angioplasty or coronary artery bypass operation can be done.

It detects the presence of abnormal arteries in and around the brain. A general look into the procedure shows that it is a special form of x-ray examination which shows the problem of the blood flow in arteries and veins. A special dye is injected into the blood stream which detects any disease like atherosclerosis which causes fatty plaques to be deposited in the lining and narrows the vessel. It is also useful in the detection of blood clots.

11.3 INFORMATION TECHNOLOGY (IT)

The rapid advancements in electronics have provided new tools such as television, computer, internet, telephone, satellites etc. Our society is changing due to developments in information technology. While watching TV or reading a newspaper or magazine, it is impossible to miss coverage on seemingly diverse topic related to information technology, internet, World Wide Web (WWW), digital TV, online learning, corporate restructuring, wireless communication, medicine and so on. IT is based on the hardware and software of a computer and the telecommunication infrastructure. Computers have been used for information processing for many years.

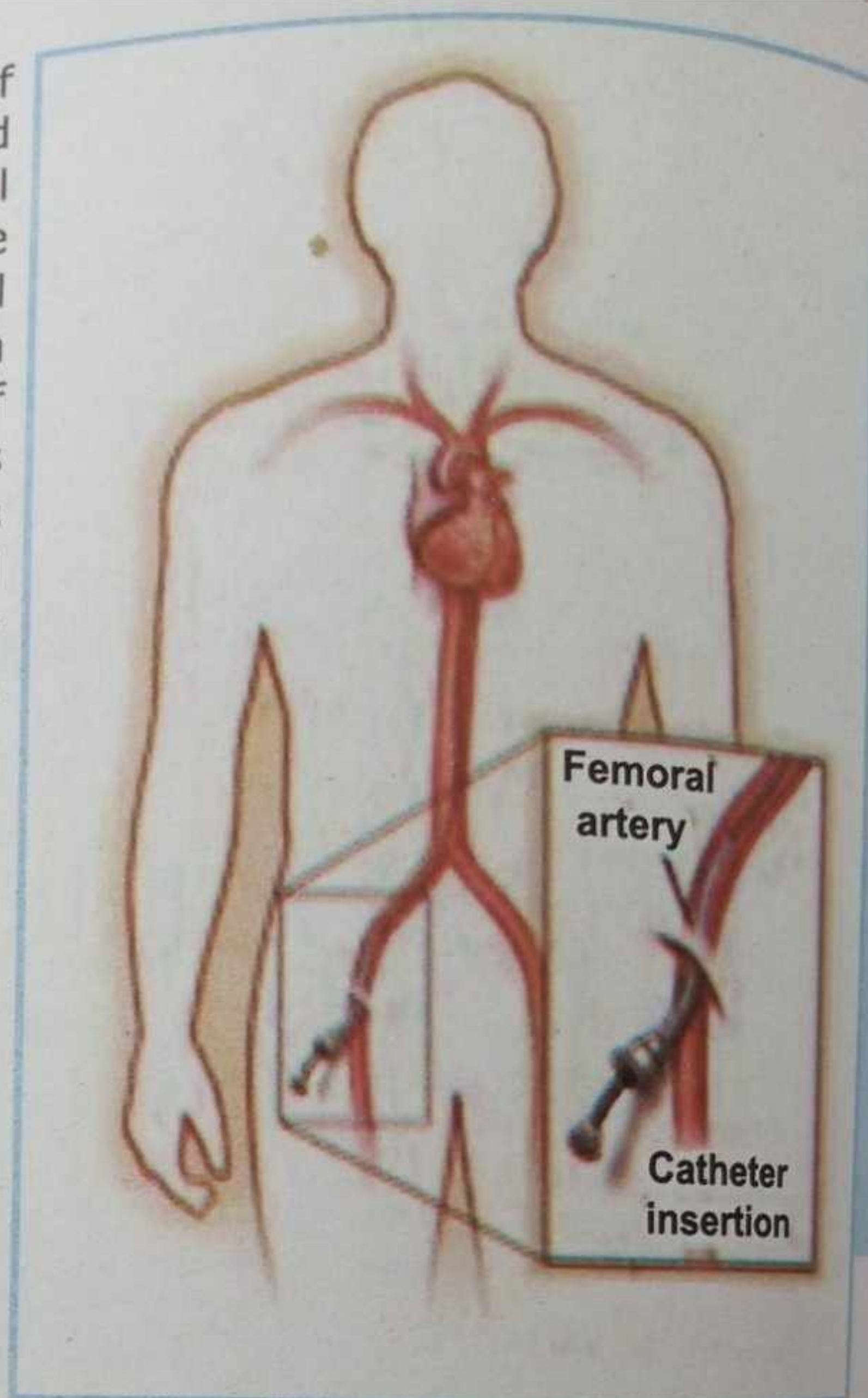


Fig: 11.15 Angiography.



Computers are becoming more and more powerful both in terms of their computational speeds and also for their capacities for storing data. Computer technology is the most useful technology ever developed. IT is the combination of computer Technology and communications.

Rapid changes are taking place in information technology all over the world. The methods used in sending information instantly over long distances are called telecommunications. The devices are television, computer, radio, telephones, fax machines etc. Let's study some devices in detail.

11.3.1 Computer

A computer is an electronic device which can solve complicated problems. It processes data, entered into it and gives out the result rapidly. There are three basic kinds of computers i.e digital computers, analog computers and hybrid computers.



Analog computer.



Digital computer



Hybrid computer

Fig: 11.16 Different types of computers.

Science Development



Digital computers are programmable so these can run variety of applications using software. Analog computers work with the physical characteristics like pressure, temperature, weight etc. Sometimes the properties of digital and analog computers are combined in a computer and such computer is called hybrid computer.

The use and importance of computer is rapidly increasing day by day. It is because of high speed processing, the reliability of handling the supplied information with accuracy, large memory and the capability of arriving at an end result. These properties have made computer to be an important tool for getting easy solutions to variety of problems we face on our daily life.

A set of computers connected through a network is called a computer network. For example, internet is a computer network. Computers connected by a network can mutually exchange information. The interconnected computers can serve as a common database.

Basic elements of a computer system

A computer system is composed of different components which work in a coordinated fashion for the accomplishment of a certain task. Overall, a computer has a hardware and a software component. The hardware components of the computer are the parts which can be touched and are visible to eyes. The software components consist programmes and applications that directs the hardware components for effective functioning. A computer has the following major parts.

- i. Central processing Units (CPU)
- ii. Memory or storage
- iii. Input Units
- iv. Output Units

The set of instructions given to a computer is called program. We enter data through input devices. An input device is any hardware component that allows a user to enter data and instructions into a computer. Input devices are mouse, keyboard, microphone, digital camera, scanners etc.

An output device is any piece of computer hardware equipment used to communicate the results of data processing carried out by a computer to the user. Output devices are monitor, printers, computer speakers etc.



Fig: 11.17 Different devices of computers.

Electronic data is stored into the memory, from where it is processed as and where instructed. Central processing unit (CPU) executes the instructions sequentially. The instructions modify data stored in memory or obtained from an input device. Processed data may be stored back in memory or sent to an output device, such as monitor. The results can be viewed on the TV screen or can be printed by the printer for permanent record.

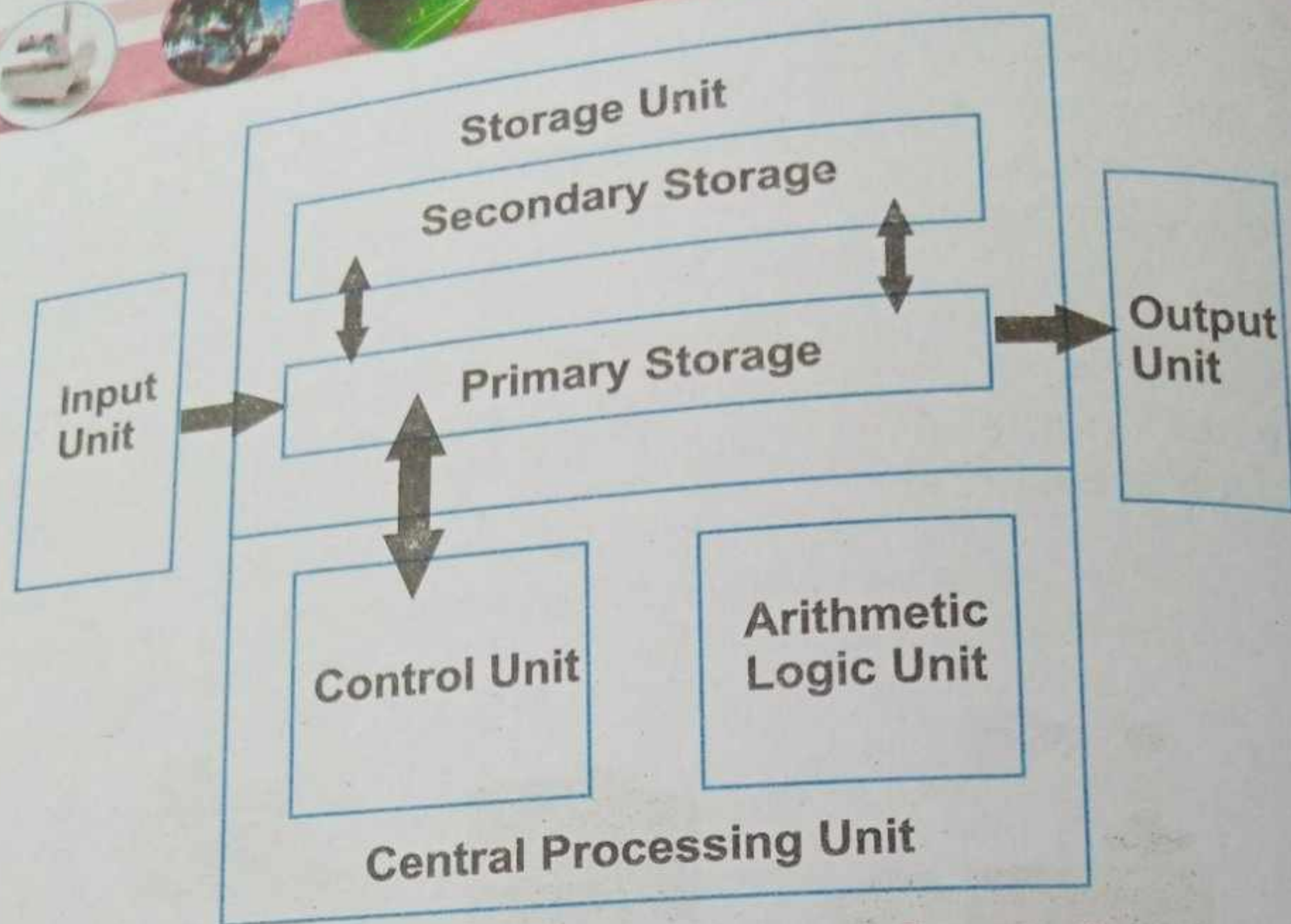


Fig: 11.18 Flow chart showing working of a computer.

There are two types of storage memory used in a computer system, primary storage and secondary storage. Primary storage is of two types; Read only Memory (ROM) and Random Access Memory (RAM). ROM is a permanent memory supplied by the manufacturer and contains all the necessary codes and instructions. RAM is a temporary memory. Secondary storage are in the form of USB (Universal serial bus), memory cards, etc. These devices give backup storage and also increases the data storage capacity.

Computer has a vital role to play in almost every field of life. In the field of education, computer provides an efficient mechanism for storage and access to information. It also preserves data for future use. Online education has made the dream of distance learning a reality. Computers help in audio-visual representation of information, thus making the process of learning interactive and interesting.

Computers are extremely important in today's business. Ordering products, shipping information, price checks in retail stores etc. is done using computers. Many businesses use accounting software and ledgering systems to ensure the accuracy of their financial status.

Computers provide a wide range of communication methods like email, social networks, chat, web and teleconferencing etc.

With the advent of Internet, we are now enjoying the benefits of high technology media which is not only faster but also wide spread in range. In manufacturing industry computers are widely used to design and manufacture products.

11.3.2 Telephone

The word tele means far or distance and phone means sound. Putting them both together it means something that lets you hear sound from a distance.

Telephone has two main parts.

1. Receiver

The receiver turns the incoming signals into sound. As the signals pass through the electromagnet, it attracts the thin metal membrane. The changes in the amplitude of the signals will vary the attraction, and thus causing the membrane to vibrate accordingly. Such vibration is transmitted in the air as sound waves. Therefore we can hear the sound.

TADBIT

In 1946 world's first commercial mobile phone service started its operation. It could link moving vehicles to a telephone network via radio waves.



2. Speaker

Most telephones use carbon powder speaker transmitter, a device to turn the sound wave into electric signals. The carbon powder is present in a case. When you speak, the sound vibrates the plastic membrane and presses the carbon powder.

The resistance of the powder drop when it is under pressure. Therefore, the sound vibration changes the electric current correspondingly.

When we speak on telephone, the sound energy changes into electrical signals. These signals travel along telephone cable and telephone receiver on other end of the lines changes the electrical signals again into sound. In the latest technology, sound signals are first converted into electrical signals which are then converted into light signals with the help of electronic circuits. These light signals travel along optical fibers. Advantage of this technology is that several thousand calls can be transmitted through a single optical fiber at the same time and there will be no interference effect of electric or magnetic fields on the light signal.

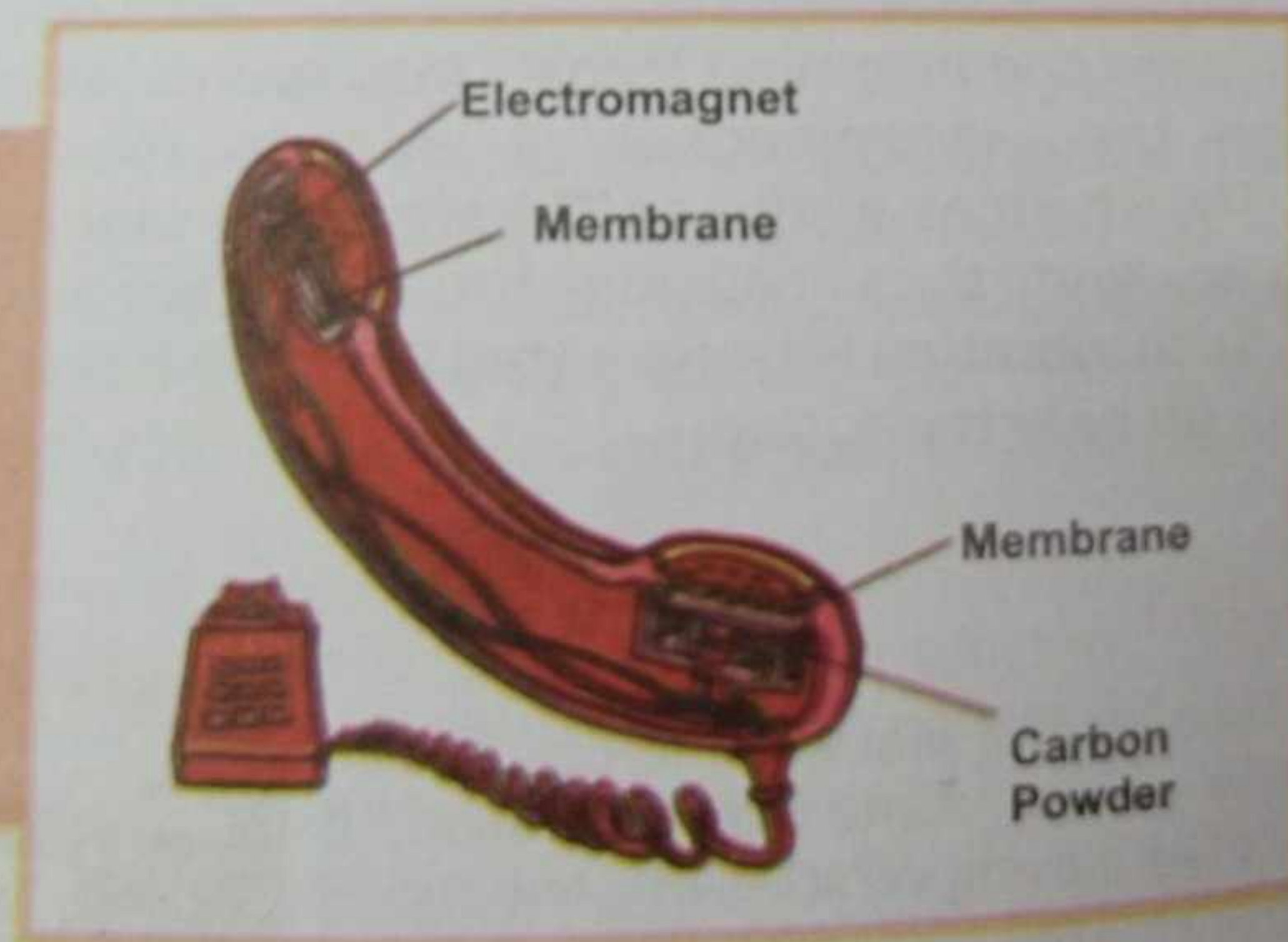


Fig: 11.19 Main parts of a telephone.

11.3.3 Fax Machine

Fax machine is used to send contents of the documents to other destinations without changing the physical version of the document. Fax is a short of facsimile, which means exact reproduction of a document print or picture. A fax machine scans a document and changes the dark and light parts into electrical signals. These signals travel along telephone cable to the receiving fax machine, which reproduces the original document. The original document is scanned with a fax machine (or a telecopier), which processes the contents (text or images) as a single fixed graphic image, converting it into a bitmap, and then transmitting it through the telephone system in the form of audio-frequency tones. The receiving fax machine interprets the tones and reconstructs the image, printing a paper copy.



Fig: 11.20 Fax Machine.

11.3.4 Radio

Radio is a source of information and entertainment even in the presence of other useful present day gadgets. A radio works with the help of radio transmitter and a radio receiver. Radio transmitter transmits sound in the form of radio waves which are received by the radio receiver.

A radio wave is an electromagnetic wave which is transmitted by an antenna. Radio waves launched from a transmitting antenna move outward and without being influenced by the surrounding atmospheric conditions like rain, snow etc. Radio waves can easily penetrate non-metallic objects. They travel best in free spaces and require no material medium for their transmission.

- Radio waves have different frequencies. For example, all FM radio stations transmit in a band of frequencies between 88 megahertz to 108 megahertz and you can tune your radio receiver to a frequency between this range for a particular FM radio station. Common radio frequency bands include:

- AM – 535 KHz to 1.7 MHz
- Citizen Band (CB) Radio – 26.96 MHz to 27.41 MHz
- Short Wave Radio – 5.9 MHz to 26.1 MHz.
- FM – 88 MHz to 108 MHz

In the radio station, a person talks in a microphone. The microphone converts the sound into electrical signals. The radio transmitter transmits the signals in the space in all directions in the form of radio waves. The radio receiver set picks up the radio waves in space by an aerial. The aerial converts the radio waves into electrical signals and sends them to the tuner in the receiver set. The radio tuner can select the transmission of a particular radio station. The tuner sends the selected signals to an amplifier. Finally, the signals reach the speaker of the radio set and are converted to sound signals.

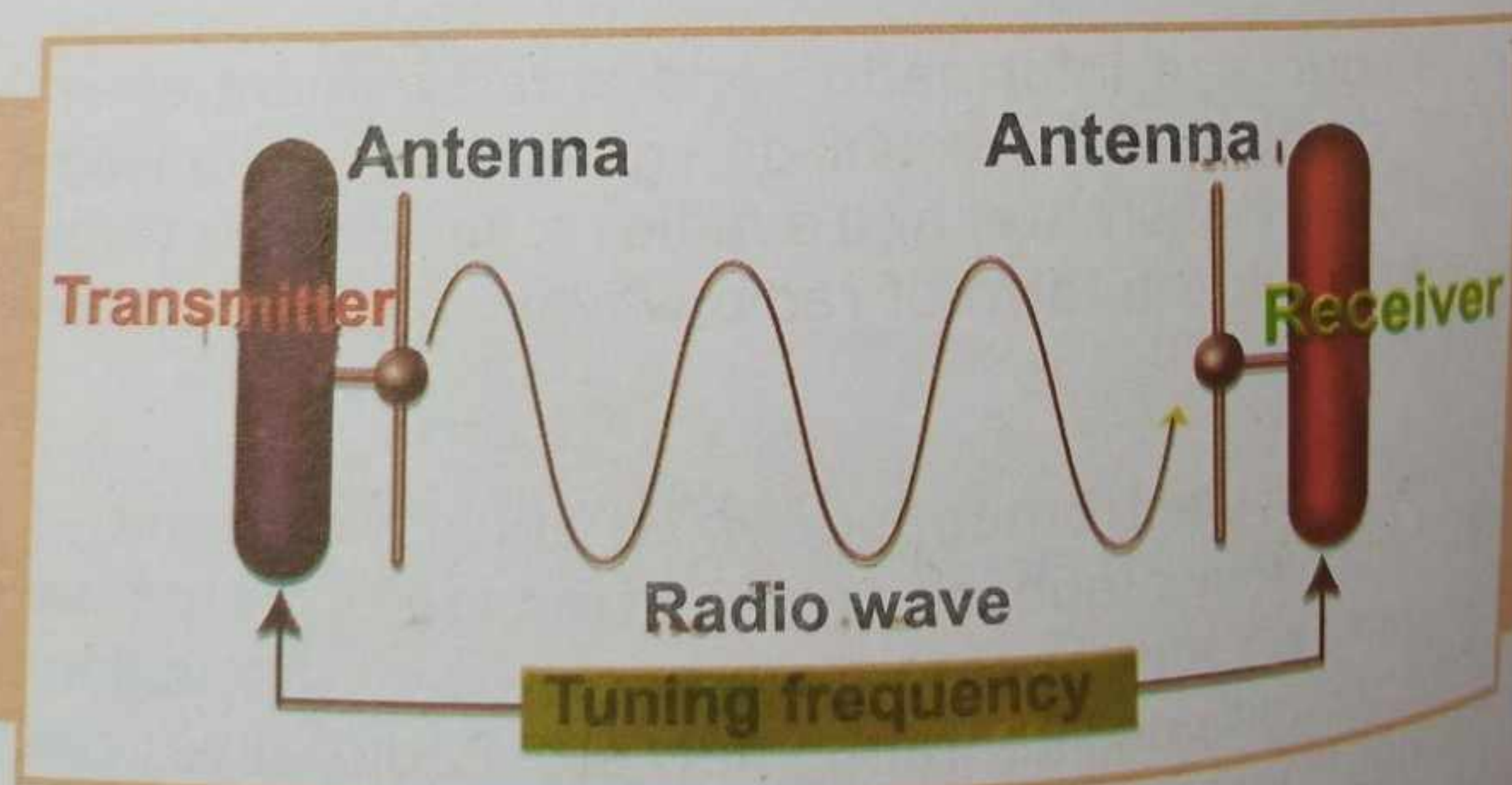


Fig: 11.21 Transmission of radio waves.

11.3.5 Television (TV)

The word television is a combination of two words, tele and vision which means seeing at a distance. Television has been influencing our lives since its invention. On one hand, it provides us entertainment and on the other hand it is a source of valuable information.



Fig: 11.22 Television.

Working of a television is based on three basic things i.e. the **TV camera** that turns a picture and sound into a signal; the **TV transmitter** that sends the signal through the air;

and the **TV receiver** (the TV set in your home) that captures the signal and turns it back into picture and sound. TV creates moving pictures by repeatedly capturing still pictures and presenting these to your eyes so quickly that they seem to be moving.

A television program is produced by focusing a television camera on a scene. The camera changes light from the scene into an electric signal, called the video signal. The video signals from the cameras are processed in a control room. Audio signals from microphones placed in or near the scene also flow to the control room, where they are amplified and combined. The signals are then sent to the transmitter.

The transmitter amplifies the video and audio signals and uses the electronic signals to modulate, or vary, carrier waves. The carrier waves are combined, and then sent to the transmitting antenna. In the antenna; the oscillations of the carrier waves generate electromagnetic waves of energy that radiate horizontally throughout the atmosphere. These waves excite weak electric currents in all television-receiving antennas within range. These currents have the characteristics of the original picture and sound currents. The currents flow from the antenna attached to the television into the television receiver, where they are electronically

separated into audio and video signals. These signals are amplified and sent to the picture tube and the speakers, where they produce the picture and sound portions of the program.

Artificial satellites

Artificial satellites move around the earth. These satellites are used to relay messages e.g. speech, conversation, pictures etc, transmitted over electromagnetic waves from one place to far off places on the earth surface which enable us to view live events, matches etc.



Fig: 11.23 Artificial satellite bring live events to our television screen.

11.3.6 Mobile or Cell phone

Cellular or mobile phone has revolutionized the communication technology worldwide. It is one of the booming industries in the world. In Pakistan mobile phone users are increasing with every passing day. Mobile phone is a type of short-wave analog or digital telecommunication in which a user has a wireless connectivity from a mobile phone to a nearby transmitter. Each of the transmitter has its own specific area of coverage which is technically called as a cell.

When the mobile phone user moves from an area to another area of coverage, the signals are passed on to the local cell transmitter operating in that specific area. When you speak into a mobile phone, the sound waves strikes the microphone in the handset which converts sound waves into electrical signals. In a mobile phone there is a microchip which converts these electric signals into radio waves which are beamed out from the antenna of the mobile. These radio waves travel through the air at the speed of light until it is received by cell phone mast which pass them to its base station. From the base station, the calls are transferred to their destination. This is how a call is made from one mobile to another mobile.

When call is from one mobile phone network to another mobile phone network or to a landline number, the radio waves travel to and are received by the main telephone network before they are routed onward to the desired destination.

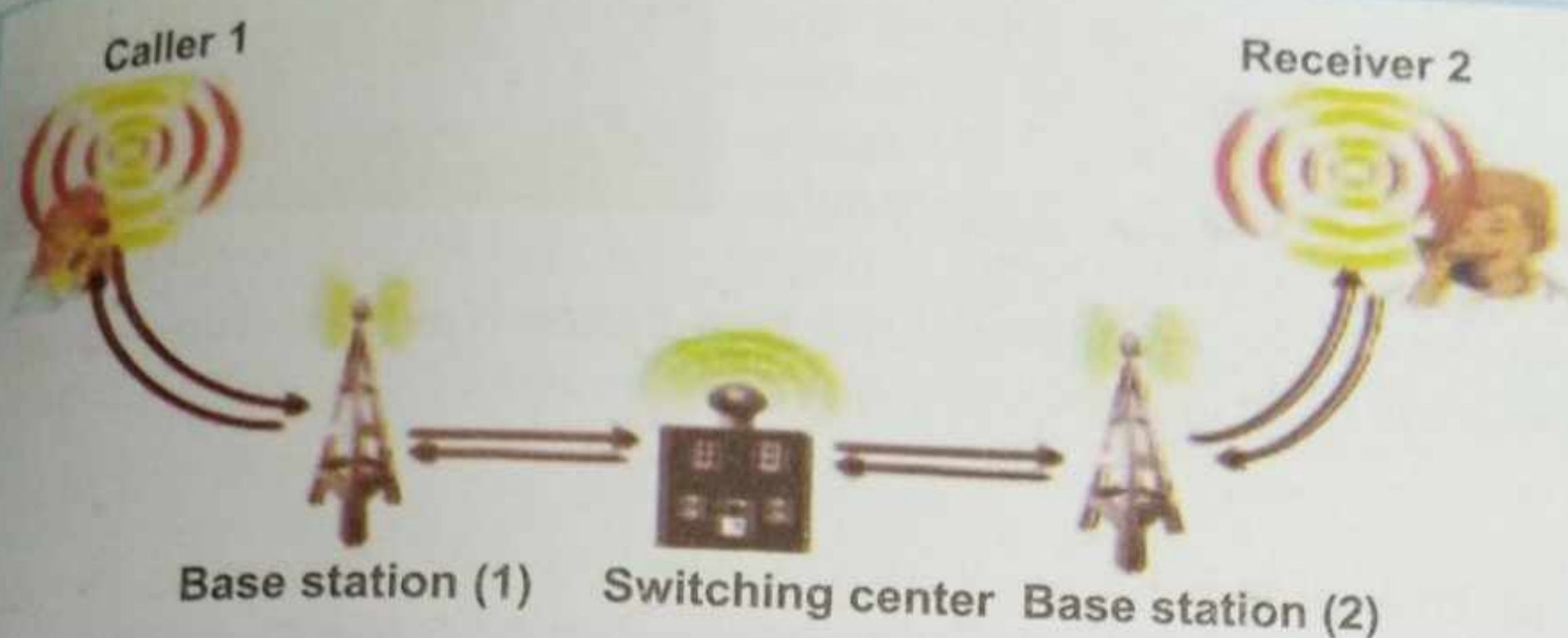


Fig: 11.24 Mechanism of cellphone calling.

11.4 Space Exploration

Human being is very conscious by nature and always tries to solve the mysteries of the events, which take place with or without his own contribution. This curiosity leads the man to enter space and to know the surroundings of the earth.

DO YOU KNOW?

On 20th July, 1969, the first man to step on the surface of moon, was Neil Armstrong,. When Neil Armstrong put his step on the surface of moon, he spoke the following historical words.



"One small step of man, one giant leap for mankind". He stayed there for about 21 hours and 37 minutes.

FOR YOUR INFORMATION

Satellite is the man-made scientific instrument (object) which is sent from the earth and restricts it to orbit around the earth. The satellites are sent into the orbit with the help of rocket. On 3rd November, 1957 the Soviet launched Sputnik-2 which weighed 508 Kg and carried the first space traveler, a dog named Laika, which survived for several days.



Space is the place beyond the earth where there is no air or atmosphere. The air which we feel is about 112 km from the surface of the earth. Beyond the boundaries of this, approximately 160 km, all the place in the universe is called space.

It was believed that the stars and the upper space play a very important role in the changes taking place on the earth. Man always tries to know about the upper atmosphere or space.

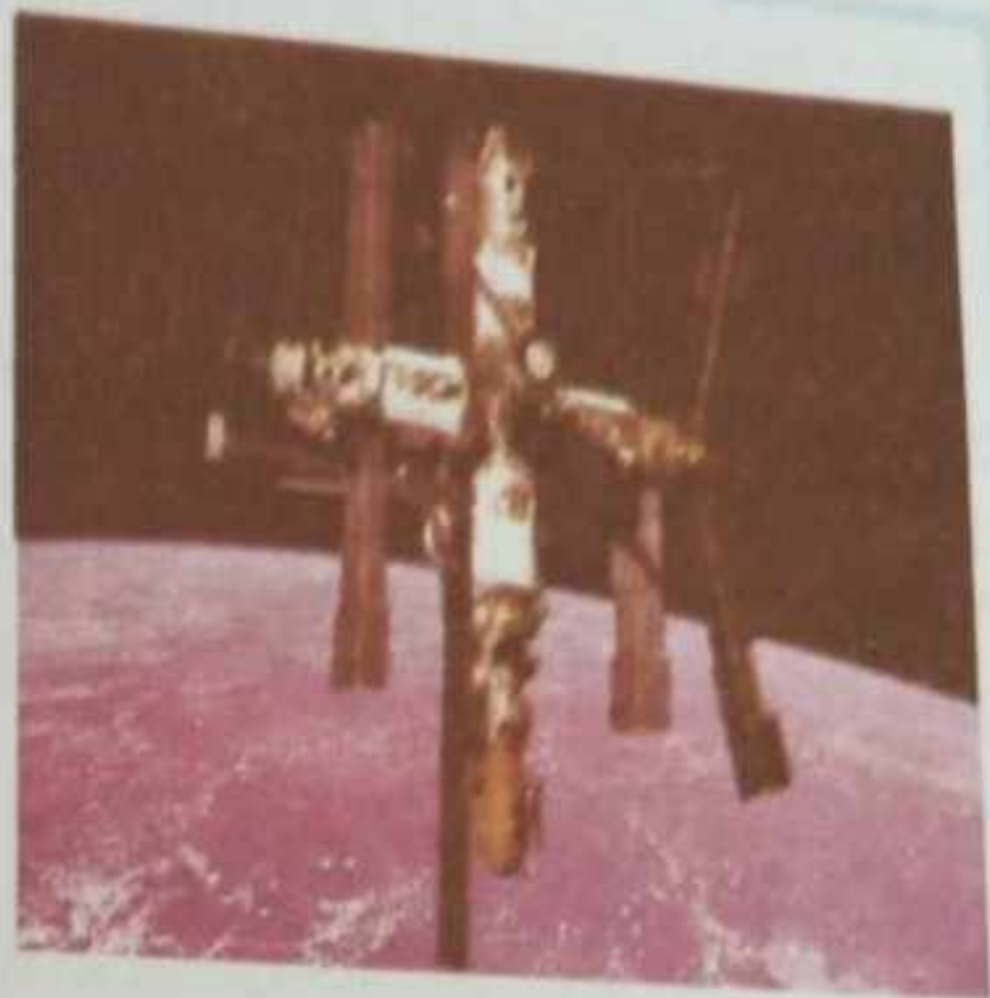
**TIDBIT**

The first T.V. relay station called Telstar was released in space in 1962.

Fig: 11.25 Layers of atmosphere on earth.

FOR YOUR INFORMATION

The word space station means the permanent station, which can be used as an experimental laboratory, where those experiments can be performed which are not possible on earth. The first idea of space station was presented by Russians. Russians sent Salyut and Mir space station, while America sent Sky Lab and space shuttle into space.



11.4.1 Pakistan Space Programme

Due to the revolution in space exploration and importance of the role of satellite in various fields, Pakistan, although a developing country also realized the importance of space and space exploration, therefore established an organization named "SUPARCO" in 1962.

SUPARCO means "Pakistan Space and Upper Atmosphere Research Commission". It is responsible for the execution of the space science and technology programmes in the country.

FUNCTIONS OF SUPARCO

Functions of the SUPARCO are:

- 1) Keeping in view the objectives of the commission it prepares and submit proposals, schemes or projects to the Government of Pakistan for getting necessary approvals.

TIDBIT

In future the space station having solar cells will be installed and their cells will generate electricity which will be sufficient for earth with microwave beam.

- ii) The commission is entrusted with the responsibility of carrying out research and application programs approved by the Government of Pakistan.
- iii) On the directives of the Government the commission conducts investigations and surveys mainly related to space and upper atmosphere.
- iv) The commission prepares and submits quarterly progress reports and its annual budget to the Government Of Pakistan for approval.

The commission consists of the following divisions

i. **Remote sensing and application Division (RSA)**

This center is for dissemination of satellite remote sensing data products. It also works on geographic information system technology for exploring earth resources, surveying, mapping and environmental monitoring.

ii. **Environmental and space science Division (E &SS)**

It carries out research in environmental pollution studies astronomy etc. and atmospheric science.

iii. **Ionosphere Research Division (IR)**

It is also Concerned with research studies about ionosphere and its effects.

iv. **Satellite communications Division (SC)**

Receive the data from the satellite.

DO YOU KNOW?

On 16th July 1990, Pakistan launched its first experimental satellite BADR-1.



Contribution of SUPARCO

This research center sent several satellites for weather research. First satellite Badar-I was sent into space in 1990 after which Badar-II was sent. Pakistan has its own communication satellite, responsible for communication all over the country. Pakistan has its own surveillance satellite, which can check each and every movement in the region. It also has monsoon watch program. Weather satellite successfully predicts the information about rain, storms, hurricanes etc.

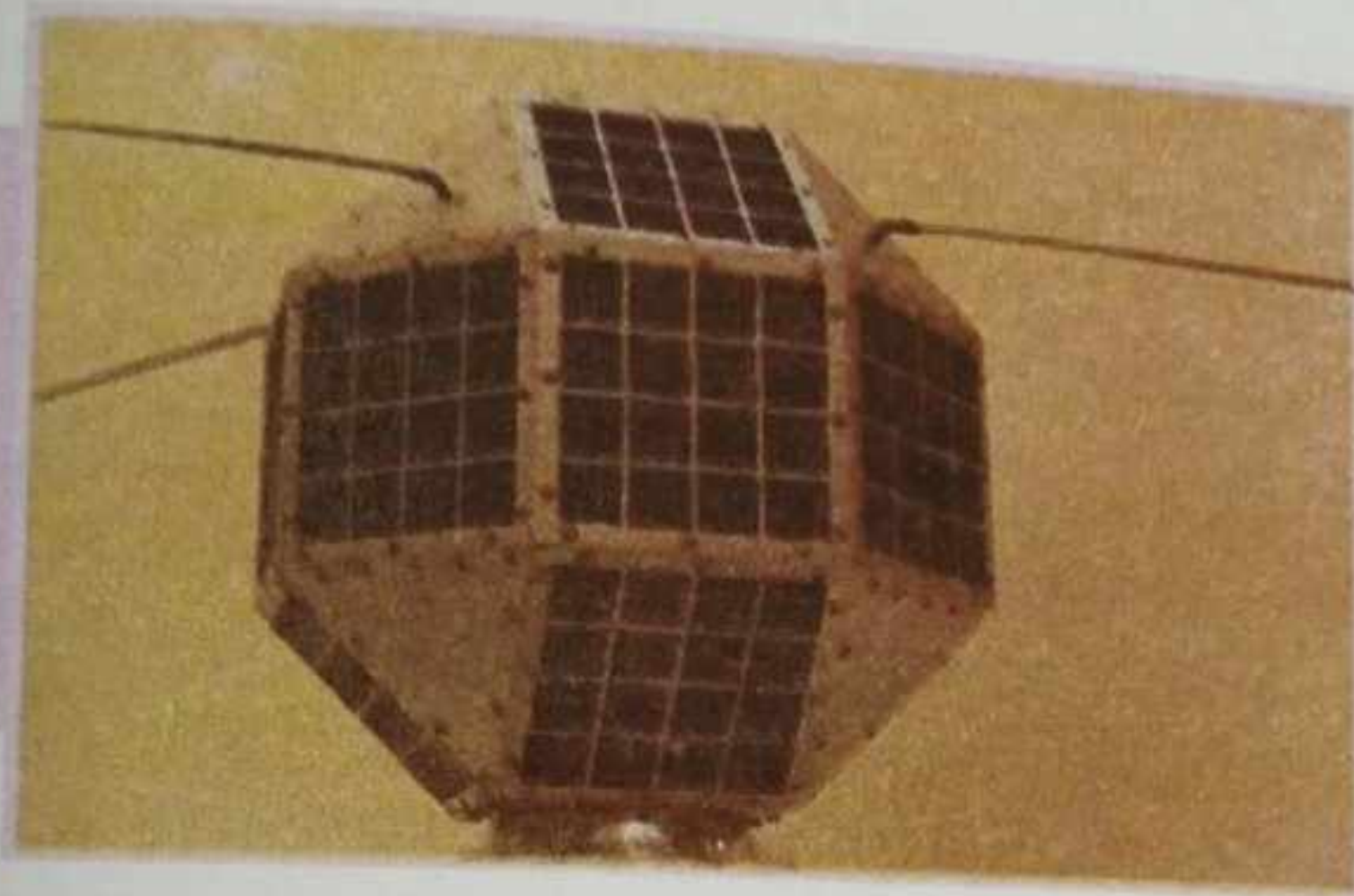


Fig: 11.26 Bader -1 satellite of Pakistan.

Future Plans of SUPARCO

Pakistan's National Satellite Development Programme (NSDP) is one of the major tasks entrusted to SUPARCO. It includes the development of the following.

- ◆ Development of effective communication Satellite
- ◆ Pakistan Remote Sensing Satellite (PRSS-1)
- ◆ Human Resource Development in the area of space exploration

In the field of Applications Programmes following fields have been focused for further studies.

- ◆ Remote Sensing Applications
- ◆ Space and Atmospheric Sciences
- ◆ Tele-Medicine

KEY POINTS

- ◆ Economic growth and well being of a country is directly related to its scientific and industrial advancement.
- ◆ Lasers are devices that produce or amplify a beam of narrow, low-divergent light with a well-defined wavelength.
- ◆ A laser consists of two fundamental elements: an amplifying medium and a pumping system.
- ◆ Fiber Optics is a data communication technology. Fiber optics move information from one place to another. However, the transmission medium is light, and that light is carried within a hair-thin optical fiber via the process of total internal reflection.
- ◆ X-rays are electromagnetic radiations which have wavelength much shorter than ultraviolet light. The major use of x-rays is in medical diagnostics and treatment. The absorption of x-rays by dense material is used for x-rays imaging of the human body.
- ◆ The sound having frequency less than 20Hz is called infrasonic and higher than 20KHz as ultrasonic.
- ◆ Electroencephalogram (EEG) is recording of the electrical activity of brain from the scalp.
- ◆ An electrocardiogram (ECG) is an electrical recording of heart which is used in the investigation of heart diseases.
- ◆ Computerised tomography scan are special x-ray tests that produce cross-sectional images of the body using x-rays and a computer.
- ◆ MRI scanners produce highly detailed two- dimensional and three- dimensional images of the human anatomy.
- ◆ Angiography is a special form of x-ray examination that shows the pattern of the blood flow in arteries and veins.

- ◆ Computer technology is the most useful technology ever developed. IT is the combination of computer Technology and the communications.
- ◆ On the basis of nature of input, computers can be classified into three types: digital computers, analog computers and hybrid computers.
- ◆ There are two types of storage memory used in a computer system, primary storage and the secondary storage.
- ◆ Computers provide a wide range of communication methods like email, social networks, chat, web and teleconferencing, etc.
- ◆ When we speak on telephone, the sound energy changes into electrical signals. These signals travel along the telephone cable and the telephone receiver on other end of the lines changes the signals again into sound.
- ◆ A fax machine scans a document and changes the dark and light parts into electrical signals.
- ◆ A radio wave is an electromagnetic wave propagated by an antenna. Radio waves have different frequencies.
- ◆ Television has been influencing our lives since its development. It is an important way of spending free time and shapes people's opinions about various issues.
- ◆ Artificial satellites move around the earth. These satellites are used to relay messages e.g. speech, conversation, pictures etc, transmitted over electromagnetic waves from one place to far off places on the earth surface which enable us to view live events, matches etc.
- ◆ SUPARCO means "Pakistan Space and Upper Atmosphere Research Commission". It is responsible for the execution of the space science and technology program in the country.

EXERCISE

A. Select the correct answers in the following questions.

1. The Laser light is:

- ☒ a. Monochromatic
- b. Coloured
- c. Chromatic
- d. None of these

2. The device that uses strong magnetic field and radio waves is:

- ☒ a. X-ray
- b. C.T scan
- c. MRI
- d. Laser

3. Artificial satellites are the objects which revolve round the:

- a. Sun
- ☒ b. Earth
- c. Star
- d. Moon

4. C.T. scan can take cross sectional images of the body by using:

- ☒ a. X-rays
- b. Laser beam
- c. Ultrasonic waves
- d. Radioactivity

5. Laser used for communication is in the form of:

- a. heat
- b. light
- c. electricity
- ☒ d. sound

6. Ultrasonic sound has the frequency:

- a. 5k Hz to 10 kHz
- b. 10 Hzk to 15k Hz
- c. 15k Hz to 20k Hz
- ☒ d. above 20k Hz

7. The light that travels along the fiber is made up of:

- a. Binary code
- b. Single code
- ☒ c. Tertiary code
- d. All of these

8. Identify an input device in the following:

- a. Monitor
- c. Printer

- b. Speaker
- d. Mouse

9. Electrocardiography is a technique of recording bio-electric currents generated by:

- a. Brain
- c. Spinal cord

- b. Heart
- d. kidneys

10. A magnetic resonance imaging scan produces cross-sectional images of the body using:

- a. Ultrasound waves
- c. X-rays

- b. Strong magnetic field and radio waves
- d. Infrared rays

11. Atherosclerosis causes fatty plaques to be deposited in:

- a. Bones
- c. Blood vessels

- b. Muscles fibers
- d. Skin

12. Identify the out put device in the following:

- a. Mouse
- c. Microphone

- b. Keyboard
- d. Printer

13. A fax machine scans a document and changes the dark and light parts into:

- a. Ultrasound waves
- c. Electrical signals

- b. Radio wave
- d. Infra red rays

14. In radio the transmitter receives the message, encodes it into a:

- a. Ultrasound waves
- c. Electrical signals

- b. Radio waves
- d. sine wave

B. Write short answers of the following questions.

1. What are the similarities and differences between MRI and CT scan.
2. How laser is used in different scientific processes.
3. Why optical fiber is better than copper cable for telecommunication?
4. What is the importance of artificial satellite in telecommunication?
5. How has mobile phone changed the life style of the people of Pakistan?
6. Differentiate between EEG and ECG.
7. Why MRI is safer than CT scan?
8. According to your opinion which technology has effected the human life a lot. Introduce this technology in few lines.

C. Write in detail answers of the following questions.

1. What are ultrasound waves? Why these waves are less harmful than X-rays.
2. How CT scan has helped in providing better way of diagnosis and treatment of diseases?

3. Describe the principle of Lasers and its uses in different fields with examples.
4. Describe the functions and uses of ECG.
5. Describe the functions and uses of EEG.
6. Describe the main components of a computer.
7. Explain the contribution SUPARCO has made in the development of our country and list their future plans.
8. Write a note on the working of a telephone.
9. What is the role of information technology in our society? How it has revolutionized the human life?

GLOSSARY

Acid: A compound that yields hydrogen ions (H^+) when in aqueous solution. Acids have a sour taste and turn blue litmus red.

Acid deposition: Precipitation with a pH less than 5.6 formed in the atmosphere when certain pollutants mix with water vapor.

Acid rain: Rain with a pH less than 5.

Alcohol: Organic compound used in gums, resins, dyes and perfumes.

Alkali: A base that is soluble in water.

Aquifer: A porous and permeable body of rock or sediment through which groundwater flows.

Base: Generally, a substance that reacts with acids to form a salt, several different definitions of bases have been proposed by different scientists (listed in parentheses).

1) (Arrhenius) a compound that releases hydroxide ions (OH^-) in solution; 2) (Bronsted-Lowry) a molecule or ion that accepts hydrogen ions from solution; 3) (Lewis) a molecule or ion that donates an electron pair to an acid.

Biodiversity: The variety and abundance of life and its ecological context, including different kinds of organisms. The numbers of species, variations in their genes, and complexity of their ecological conditions.

Biomass: The combined mass of living or once-living organisms in a given area.

Biotechnology: It is the exploitation of biological processes for industrial and other purposes, especially the genetic manipulation of microorganisms for the production of antibiotics, hormones, etc.

Bond: The force that holds together units such as atoms or molecules.

Chemical reaction: The transformation of substances by the rearrangement of their atoms.

Chromosome: The organized genetic structure of DNA with associated proteins that contains the hereditary information necessary for reproduction, protein manufacture, and other functions.

Chlorofluorocarbons: Compounds consisting of carbon, chlorine, fluorine, and sometimes hydrogen once used widely as aerosol propellants and refrigerants.

Cramp: A sustained and involuntary contraction of the muscle.

Combustion: Commonly referred to as burning, a chemical reaction between a fuel (for example wood) and an oxidizing agent (for example oxygen) that produces heat (and usually, light).

Deoxyribonucleic acid: A double-stranded, helical polymer of the sugar deoxyribose, phosphate, and one of four nucleotide bases (Adenine, Cytosine, Guanine, and Thymine). The molecule is the primary carrier of genetic information in all cells.

Desalinization: To remove salts and other chemicals from sea or saline water.

Earthquake: It is a sudden violent shaking of the ground, typically causing great destruction, as a result of movements within the earth's crust or volcanic action.

Ecosystem: A community of living organisms and their interrelated physical and chemical environment.

Electric current: A flow of electrons through a conductor, the amount of the current is proportional to the rate of electron flow.

Electrons: Negatively charged atomic particles.

Electronic communication: System for the transmission of information using electronic technology (e.g., digital cameras, cellular telephones, Internet, television, fiber optics).

Endothermic reaction: A reaction in which heat is absorbed i.e melting or boiling.

Energy: The capacity to do work. Work is done by transferring energy from one form to another. For example the chemical energy in a fuel is converted to thermal energy as it burns.

Environment: The total of the surroundings (air, water, soil, vegetation, people, wildlife) influencing each living being's existence, including physical, biological and all other factors.

Enzyme: A protein that increases the rate of a chemical reaction without being changed by the reaction; an organic catalyst.

Electrical charge: A fundamental property used to explain attraction and repulsion between certain particles. Two types of charge exist: negative charge, which is generally conveyed as an excess of electrons, and positive charge, which is generally conveyed as a lack of electrons and excess of protons.

Erosion: The action or process of eroding: wearing away by the action of water, wind, glacial ice, etc.

Exothermic reaction: A process or reaction that releases heat. Wood burning in the presence of oxygen is an example of an exothermic reaction.

Equilibrium: The ability of an ecosystem to maintain stability among its biological resources (e.g., forest, fisheries, crops) so that there is a steady optimum yield.

Evaporation: The change of state of a substance from a liquid to a gas below its boiling point.

Extinction: The complete elimination of a species from the earth.

Gene: Material (usually DNA) that is inherited from a parent and which encodes instructions for some cellular function.

Greenhouse gas: A greenhouse gas is a component of the atmosphere that absorbs heat radiated by the Earth and subsequently warms the atmosphere, creating what is commonly known as the greenhouse effect.

Groundwater: Water that fills pore space in rocks and sediments and forms a subsurface aquifer. Groundwater is distinct from soil moisture which does not completely fill pore spaces and is immediately beneath the surface.

Hazardous waste: A solid that because of its quantity or concentration or its physical, chemical or infectious characteristics, may cause or pose a substantial presence or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise managed.

Incinerating: Burning to ashes; reducing to ashes.

Information technology: The technical means that humans create to store and transmit information.

Natural resources: Materials produced through or contained within Earth's natural systems and used by humans and other

species. They include minerals and soil, water, air, and various plant and animal species (such as trees cut for wood, fish eaten for protein, and bees that pollinate plants).

Nitrification: The oxidation (as by bacteria) of ammonium salts to nitrites and the further oxidation of nitrites to nitrates.

Nitrogen fixation: The assimilation of atmospheric nitrogen into ammonia, most commonly through metabolic processes of soil microorganisms. Other agents of nitrogen fixation include lightning, forest fires, and the industrial process used to manufacture synthetic fertilizers.

Nucleotide: The building blocks of DNA and RNA, consisting of a nitrogen base, a five-carbon sugar, and one or more phosphate groups.

Organic compounds: Substances that contain Carbon.

Ozone: An isotope of oxygen that blocks ultra-violet radiation.

Ozone layer: A layer of higher than average concentration of ozone within the stratosphere. Within the ozone layer, concentrations are still in the range of 8-12 parts per million (ppm); concentrations outside of the ozone layer are around 0.02 ppm.

pH Scale: The strength of acids and bases. Pure water has a pH value of 7, acids have a lower value and bases higher.

Reactants: The substances that take part in a chemical reaction.

Radioactivity: The spontaneous emission of radiation due to a nuclear reaction or direct emission from an unstable atomic nucleus. Radioactivity takes several different forms, including the emission of alpha particles, beta rays, or gamma rays.

Reactant: The initial material that participates in a chemical reaction. Written on the left side of a chemical equation.

RNA: Ribonucleic acid. A single-stranded nucleic acid containing the sugar ribose. In most organisms, a molecule responsible for transfer of the genetic information encoded in DNA for manufacture of proteins. In some organisms such as viruses RNA is the primary carrier of genetic information.

Recycling: Collecting and reprocessing a resource or product to make new products.

Reduction: A chemical reaction in which electrons are gained, or the chemical addition of hydrogen takes place.

Renewable: A naturally occurring raw material or form of energy that will be renewed through natural ecological cycles or sound management practices (e.g., the sun, wind, water, trees).

Saponification: The process of converting a fat or an oil into soap through combination with an alkali.

Ultraviolet: Wavelengths between 1 and 380 nanometers (nm) on the electromagnetic spectrum falling between X-rays (10-2 nm to 1 nm) and visible light (380 nm to 780 nm) are known as Ultraviolet or UV radiations. These cause sunburn and certain skin cancers.

X-ray: Electromagnetic radiation with wavelengths between those of ultraviolet and gamma rays, approximately 0.01-10 nm.

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