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SCIENCE AND TECHNOLOGY IN INDIA

Like people in any other part of the world Indians too, have a rich legacy of scientific ideas. A desire to now the unknown, accompanied with experimentation and observation have always generated scientific temper. This has led to the assumption that truth lay in the real world with all its diversity and complexity. It has been the responsibility of scientists to unravel the mystery behind the truth and utilise available resources for the progress of humanity. 1n the following pages you will be reading about this continuous search for knowledge and truth leading to discoveries and inventions and their application in day-to-day life in India.

OBJECTIVES

After reading this lesson you will be able to:

- *identify the development of science in India;*
- *recognise the various scientific fields in which Indians have made their contributions;*
- *examine the various forces and factors that help in developing science during any period; and*
- *draw linkages between modern Indian science and its rich scientific heritage.*

14.1 DEVELOPMENT OF SCIENCE IN ANCIENT INDIA

Mathematics has been called by the general name of Ganita which includes Arithmetic's, Geometry, Algebra, Astronomy and Astrology. Arithmetic is called by several names such

as Pattin Ganita (calculations on board), Anka Ganita (calculations with numerals). Geometry is called Rekha Ganita (line works) and Algebra, Bija Ganita (seed analysis), Astronomy and Astrology are included in the term Jyotisa.

India has a rich heritage of science and technology. The dependence on nature could be overcome by developments in science. In ancient India, religion and science worked in close proximity. Let us find out about the developments in the different branches of science in the ancient period.

Astronomy

Astronomy made great progress. The movement of planets came to be emphasized and closely observed. *Jyotishvedanga* texts established systematic categories in astronomy but the more basic problem was handled by Aryabhatta (499 AD). His *Aryabhattiya* is a concise text containing 121 verses. It contains separate sections on astronomical definitions, methods of determining the true position of the planets, description of the movement of the sun and the moon and the calculation of the eclipses. The reason he gave for eclipse was that the earth was a sphere and rotated on its axis and when the shadow of the earth fell on the moon, it caused Lunar eclipse and when the shadow of the moon fell on the earth, it caused Solar eclipse. On the contrary, the orthodox theory explained it as a process where the demon swallowed the planet. All these observations have been described by Varahamihira in Panch Siddhantika which gives the summary of five schools of astronomy present in his time. Aryabhatta deviated from Vedic astronomy and gave it a scientific outlook which became a guideline for later astronomers. Astrology and horoscope were studied in ancient India. Aryabhatta's theories showed a distinct departure from astrology which stressed more on beliefs than scientific explorations.

Mathematics

The town planning of Harappa shows that the people possessed a good knowledge of measurement and geometry. By third century AD mathematics developed as a separate stream of study. Indian mathematics is supposed to have originated from the Sulvasutras.

Apastamba in second century BC, introduced practical geometry involving acute angle, obtuse angle and right angle. This knowledge helped in the construction of fire altars where the kings offered sacrifices. The three main contributions in the field of mathematics were the notation system, the decimal system and the use of zero. The notations and the numerals were carried to the West by the Arabs. These numerals replaced the Roman numerals. Zero was discovered in India in the second century BC. Brahmagupta's Brahmasputa Siddhanta is the very first book that mentioned 'zero' as a number, hence, Brahmagupta is considered as the man who found zero. He gave rules of using zero with other numbers. Aryabhatta discovered algebra and also formulated the area of a triangle, which led to the origin of Trignometry.

The *Surya Siddhanta* is a very famous work. Varahamihira's *Brihatsamhita* of the sixth century AD is another pioneering work in the field of astronomy. His observation that the moon rotated around the earth and the earth rotated around the sun found recognition and later discoveries were based on this assertion. Mathematics and astronomy together ignited interest in time and cosmology. These discoveries in astronomy and mathematics became the cornerstones for further research and progress.

Medicine

Diseases, cure and medicines were mentioned for the first time in the Atharva Veda. Fever, cough, consumption, diarrhoea, dropsy, sores, leprosy and seizure are the diseases mentioned. The diseases are said to be caused by the demons and spirits entering one's body. The remedies recommended were replete with magical charms and spells.

From 600 BC began the period of rational sciences. Takshila and Taranasi emerged as centres of medicine and learning. The two important texts in this field are *Charaksamhita* by Charak and *Sushrutsamhita* by Sushruta. How important was their work can be understood from the knowledge that it reached as far as China, Central Asia through translations in various languages.

The plants and herbs used for medicinal purposes have been mentioned in *Charaksamhita.* Surgery came to be mentioned as a separate stream around fourth century AD. Sushruta was a pioneer of this discipline. He considered surgery as "the highest division of the healing arts and least liable to fallacy". He mentions 121 surgical instruments. Along with this he also mentions the methods of operations, bone setting, cataract and so on. The surgeons in ancient India were familiar with plastic surgery (repair of noses, ears and lips). Sushruta mentions 760 plants. All parts of the plant roots, barks, flowers, leaves etc. were used. Stress was laid on diet (e.g. salt free diet for nephrites). Both the *Charaksamhita* and the *Sushrutsamhita* became the predecessors of the development of Indian medicine in the later centuries. However, surgery suffered in the early medieval time since the act of disecting with a razor became the work of a barber.

Metallurgy

The glazed potteries and bronze and copper artefacts found in the Indus valley excavations point towards a highly developed metallurgy. The vedic people were aware of fermenting grain and fruits, tanning leather and the process of dyeing.

By the first century AD, mass production of metals like iron, copper, silver, gold and of alloys like brass and bronze were taking place. The iron pillar in the Qutub Minar complex is indicative of the high quality of alloying that was being done. Alkali and acids were produced and utilised for making medicines. This technology was also used for other crafts like producing dyes and colours. Textile dyeing was popular. The Ajanta frescoes reflect on the quality of colour. These paintings have survived till date.

A two metre high bronze image of Buddha has been discovered at Sultanganj (Near Bhagalpur)

Geography

The constant interaction between man and nature forced people to study geography. Though the people were clear about their own physical geography, that of China and also the Western countries, they were unaware of their position on the earth and the distances with other countries. Indians also contributed to shipbuilding. In the ancient period, voyages and navigation was not a familiar foray for the Indians. However, Lothal, a site in Gujarat has the remains of a dockyard proving that trade flourished in those days by sea. In the early medieval period with the development of the concept of *tirtha* and *tirtha yatra*, a vast mass of geographical information was accumulated. They were finally compiled as parts of Puranas. In many cases separate *sthala purana* was also compiled.

INTEXT QUESTIONS 14.1

1. What is the importance of developing science?

2. What was the contribution of Aryabhatta in Astronomy?

3. Who was Apastamba? What was his contribution to Mathematics?

4. What were the three contributions in the field of mathematics of Ancient India?

5. Which book mentions plants and herbs used for medicinal purposes in Ancient India?

6. How many surgical instruments were mentioned in Sushrutsamhita?

7. Name the two books which became predecessors of the development of Indian Medicine?

8. How many medicinal plants were the surgeons of ancient India familiar with?

Notes

14.2 SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENTS IN MEDIEVAL INDIA

During the medieval period (eleventh to eighteenth century) science and technology in India developed along two lines: one concerned with the already charted course of earlier traditions and the other with the new influences which came up as a result of Islamic and European influence. The *maktabs* and *madrasas* came into existence that followed a set curricular. These institutions used to receive royal patronage. The two brothers, Sheikh Abdullah and Sheikh Azzizullah, specialists in Rational Sciences *(Magulat)*, headed the *madrasas* at Sambhal and Agra. Learned men from Arabia, Persia and Central Asia were invited to teach in these *madrasas*.

A large number of *karkhana* (workshops) were maintained by the kings and the nobles to supply provisions, stores and equipment to royal household and government departments. The *karkhanas* not only worked as manufacturing agencies but also served as centres for technical and vocational training to young men. The *karkhanas* trained and turned out artisans and craftsmen in different branches, who later set up their own independent *karkhanas* (workshops).

Muslim rulers attempted to reform the curriculum of primary schools. Some important subjects like arithmetic, mensuration, geometry, astronomy, accountancy, public administration and agriculture were included in the course of studies for primary education. Though special efforts were made by the rulers to carry out reforms in education, yet science did not make much headway during this period. Efforts were made to seek a kind of synthesis between the Indian traditional scientific culture and the prevalent approach to science in other countries.

Biology

Hamsadeva compiled *Mrga-pasi-sastra* in the thirteenth century which gives a general, though not always scientific account of some of the beasts and birds of hunting. The medieval rulers as warriors and hunters, kept animals such as horses, dogs, cheetahs and falcons. Animals, both domesticated and wild, existed in their menageries. Akbar showed special interest in producing good breeds of domestic animals, elephants and horses. Jahangir, in his *Tuzuk-i-Jahangiri*, recorded his observations and experiments of weeding and hybridisation. He described about thirty-six species of animals.

His court artists, specially Mansur, produced elegant and accurate portraiture of animals, some of which are still preserved in several museums and private collections.

As a naturalist, Jahangir was interested in the study of plants and his court artists in their floral portraiture describe some fifty-seven plants.

Mathematics

Brahmagupta the great 7th century mathematician has given a description of negative numbers as debts and positive numbers as fortunes, which shows that ancient Bharatiyas knew the utility of mathematics for practical trade.

In the early medieval period the two outstanding works in mathematics were *Ganitasara* by Sridhara and *Lilavati* by Bhaskara. *Ganitasara* deals with multiplication, division, numbers, cubes, square roots, mensuration and so on. Ganesh Daivajna produced Buddhivilasini, a commentary on *Lilavati*, containing a number of illustrations. In 1587, *Lilavati* was translated into Persian by Faidi. *Bija Ganita* was translated by Ataullah Rashidi during Shah Jahan's reign. Nilkantha Jyotirvid, a courtier of Akbar, compiled *Tajik*, introducing a large number of Persian technical terms. Akbar ordered the introduction of mathematics as a subject of study, among others in the educational system. Bahauddin-Amuli, Nasiruddin Tusi, Arraq and Al-Kashi made valuable contributions to this field. Nasiruddin Tusi, the founder director of the Maragha observatory, was recognised as an authority.

Chemistry

Before the introduction of writing paper, ancient literature was preserved generally on palm leaves in South India and birch-bark *(bhoj-patra)* in Kashmir and other northern regions of the country. Use of paper began during the Medieval period. Kashmir, Sialkot, Zafarabad, Patna, Murshidabad, Ahmedabad, Aurangabad, Mysore were well-known centres of paper production. During Tipu's time, Mysore possessed a paper-making factory, producing a special type of paper that had a gold surface. The paper making technique was more or less the same throughout the country, differing only in preparation of the pulp from different raw materials.

The Mughals knew the technique of production of gunpowder and its use in guns. Indian craftsmen learnt the technique and evolved suitable explosive compositions. They were aware of the method of preparation of gunpowder using saltpetre, sulphur and charcoal in different ratios for use in different types of guns.. The principal types of fireworks included those which pierced through air (rockets), produced sparks of fire, blazed with various colours and ended with explosion. *Tuzuk-i--Baburi* gives an account of the casting of cannons. The melted metal was made to run into the mould till full and then cooled down. Besides explosives, other items were also produced. *Ain-i-Akbari* speaks of the 'Regulations of the Perfume Office of Akbar'. The attar of roses was a popular perfume, the discovery of which is attributed to the mother of Nurjehan. Mention may also be made here of the glazed tiles and pottery during the period.

Astronomy

In astronomy, a number of commentaries dealing with the already established astronomical

Notes

notions appeared. Ujjain, Varanasi, Mathura and Delhi were the main observatories. Firoz Shah Tughaq established observation posts at Delhi. Firoz Shah Bahmani under Hakim Hussain Gilani and Syed Muhammad Kazimi set up an observatory in Daulatabad. Both lunar and solar calendars were in use.

Mehendra Suri, a court astronomer of Firoz Shah developed an astronomical instrument called *Yantraja.* Parameshvara and Mahabhaskariya were famous families of astronomers and almanac-makers. Nilakantha Somasutvan produced a commentary on Aryabhatta. Kamalakar studied the Islamic ideas on astronomy. He was an authority on Islamic knowledge as well. Jaipur Maharaja, Sawai Jai Singh II set five astronomical observatories in Delhi, Ujjain, Varanasi, Mathura and Jaipur.

Medicine

There was an attempt to develop specialised treatises on different diseases. Pulse and urine examinations were conducted for diagnostic purposes. The *Sarangdhara Samhita* recommends use of opium for medicines. The *rasachikitsa* system, dealt principally with a host of mineral medicines including metallic preparations. The *Tuhfat-ul-Muminin* was a Persian treatise written by Muhammad Munin in seventeenth century which discusses the opinions of physicians.

The Unani Tibb is an important system of medicine which flourished in India in the medieval period. Ali-bin-Rabban summarized the whole system of Greek medicine as well as the Indian medical knowledge in the book *Firdausu-Hikmat.* The Unani medicine system came to India along with the Muslims around the eleventh century and soon found a congenial environment for its growth. Hakim Diya Muhammad compiled a book, *Majiny-e Diyae*, incorporating the Arabic, Persian and Ayurvedic medical knowledge. Firoz Shah Tughlaq wrote a book, *Tibbe Firozshahi.* The *Tibbi Aurangzebi*, dedicated to Aurangzeb, is based on Ayurvedic sources. The *Musalajati-Darashikohi* of Nuruddin Muhammad, dedicated to Darashikoh deals with Greek medicine.

Agriculture

In the medieval period, the pattern of agricultural practices was more or less the same as that in early and early ancient India. Some important changes, however, were brought about by the foreigners such as the introduction of new crops, trees and horticultural plants. The principal crops were wheat, rice, barley, millets, pulses, oilseeds, cotton, sugarcane and indigo. The Western Ghats continued to yield black pepper of good quality and Kashmir maintained its tradition for saffron and fruits. Ginger and cinnamon from Tamilnadu, cardamom, sandalwood and coconuts from Kerala were becoming increasingly popular. Tobacco, chillies, potato, guava, custard apple, cashew and pineapple were the important new plants which made India their home in the sixteenth and seventeenth centuries. The region of Malwa and Bihar were also well known for the production of opium from the poppy plants. Improved horticultural methods were adopted with great success. The

systematic mango grafting was introduced by the Jesuits of Goa in the middle of the sixteenth century.

In the field of irrigation, wells, tanks, canals, *rahats*, *charas* (bucket made of leather) and *dhenkli*, were used to lift water with the help of yoked oxen, which continued to be the means of irrigation. Persian wheel was used in and around Agra region. In the medieval period, agriculture was placed on a solid foundation by the State which brought about a system of land measurement and land classification, beneficial both to the rulers and to the tillers.

INTEXT QUESTIONS 14.2

1. What were the functions of Karkharnas in Medieval India?

   _____

2. Who compiled Mrga-Paksi-Sastra in the 13th Century?

   _____

3. Who was the founder director of the Maragha Observatory?

   _____

4. Who got Lilavati translated into Persian?

   _____

5. Which Mughal king introduced Mathematics as a subject of study?

   _____

6. How was literature preserved before the invention of paper?

   _____

7. Which book gives an account of the casting of cannons in Medieval period?

   _____

8. Name the perfume discovered by the mother of Nur Jehan?

   _____

9. What does Ain-i-Akbari speak about?

   _____

10. How many observatories were set up by Maharaja Sawai Jai Singh II of Jaipur? Where were these observatories located?

    _____

11. Who developed Yantraja?

_____

12. What was Yantraja?

_____

13. Which Unani medicine system came to India alongwith Mughals in medieval period?

_____

14. What was the Rasachikitsa deal with?

_____

15. Which new plants arrived in India in the 16th and 17th centuries?

_____

14.3 SCIENCE AND TECHNOLOGY IN MODERN INDIA

Before considering the progress of science and technology in India since independence, it is necessary to understand what we mean by the terms science and technology. Science can be defined as any systematic activity that seeks to gain knowledge about the physical world. Technology is that activity which seeks to put this knowledge to productive use. As these definitions show, science and technology are clearly interlinked in the present day world.

In India the role of science and technology in national development has been duly recognised by the government. The Second Five Year Plan emphasised that "the most important single factor in promoting economic development is the community's readiness to apply modem science and technology". In 1971, the Department of Science and Technology (DST) was set up to promote new areas of science and technology. Similarly State Councils of Science and Technology have also been established at the state levels. As part of the national policy, the government is promoting various research and development schemes to encourage scientific activities. In this section, we will take up some of the main areas in which scientific knowledge and modem technology have made an impact.

Agriculture

It is mainly because of the application of modern science and technology in agriculture that India is able to produce 135 million tonnes of foodgrains today as compared to 50 million tonnes thirty years ago. These applications range from the cultivation of hybrid seeds to energy management in agriculture and post-harvest technology. In these efforts the Indian Council for Agricultural Research has played a leading role. Through seventy three agricultural, thirty two veterinary, eight agricultural engineering and one dairy colleges, the

ICAR has been playing a key role in the scientific education of the farmers as well as others engaged in different sectors of agriculture, animal husbandry, fisheries and forestry. The challenges that lie ahead in agriculture are in the areas of increasing the yields of rice, pulses, oilseeds and many cash crops; initiating plantations and promoting social forestry; and shifting from agriculture based on chemical fertilizers to organic fertilizers.

Industry

It is in the field of industry that modern science and technology made its earliest and most revolutionary impact. In India the government has consistently tried to use modern science and technology for industrial development. Two government organisations, Council for Scientific and Industrial Research (CSIR) and Defence Research and Development Orgnisation (DRDO) cover between them a wide range of science and technology research for civil and defence purposes. A large number of items have emerged from CSIR laboratories for industrial production, such as, indigenous agricultural machinery, chemicals, drugs and pesticides, products in the areas of food technology, furnished leather goods, glass and ceramics, colour television, and receiver sets. The research carried out in the field of coal, such as, upgrading of coal and extraction of electricity from coal has been effectively utilized. In the area of defence, India's own technological capability has increased considerably. The most recent example of such capability is the advanced research that is now being done to produce missiles in India. Some missiles have already been tested for further development.

Nuclear Energy

India's aim is to utilise nuclear energy for peaceful purposes. During the last sixty three years, since the establishment of the Atomic Energy Commission in 1948, India has made significant progress in the field of nuclear technology. In 1957, the Bhabha Atomic Research Centre (BARC) was established at Trombay. It is the largest single scientific establishment in the country. Nuclear power stations have already been established at Tarapur (Maharashtra), Kota (Rajasthan), Kalpakkam (Tamil Nadu), Narora (UP) and Kakrapar (Gujarat). The adoption of modern technology has led to the increase in indigenous content of nuclear power reactors constructed in India. As a result, India is today one of the few countries in the world which can indigenously design, construct and operate nuclear reactors without relying on foreign help. Besides nuclear sciences, research and development work in fields such as electronics, medicine, biology, agriculture, metallurgy is also being done at some nuclear centres.

Space Technology

The Indian space programme is directed towards the goal of self-reliance in the use of space technology for national development. Over the years, the space programme has established itself with a succession of achievements. They include the launching of the first Indian space satellite Aryabhatta in 1975 and then Bhaskara I and Bhaskara II from the

Soviet Union, the Rohini satellite on India's own SLV-3 rocket and the Apple satellite on the European Arianne rocket. A far reaching experiment in education through satellite, SITE, was conducted in India in 1975. Subsequently, INSAT I-IB, launched in 1983, provided radio, television, telecommunication and meteorological services. A perspective of major space mission planned for the decade 1985-95 aims at using space technology for nationwide application in communication, survey and management of natural resources and meteorology.

Electronics

Since independence, India has acquired the capability to produce a wide variety of electronic goods such as radio and television sets, communication systems, broadcasting equipments, radars, nuclear reactors, power control systems and underwater systems. A very large part of the components required for these are produced indigenously. The production of electronic goods has been growing at the rate of 18 per cent per annum over the past decade. Today we are even exporting electronic goods to different parts of the world. Further, computers have been introduced to improve efficiency and enhance production. Major facilities, recently set up, include the Semi Conductor Limited (Chandigarh), National Computer Centre (Bombay), National Information Centre (New Delhi) and a number of regional computer centres.

Medical and Health Sciences

In the field of medicine there have been many achievements. Major advances have been made in preventing and treating various diseases. Small pox has been eradicated. Treatment of diseases like tuberculosis, malaria, filaria, goitre, and cancer has been considerably improved. Research is being carried out to control communicable diseases. Research based activities have already increased life expectancy appreciably and death rate has declined, while schemes such as the immunisation programme have reduced infant mortality considerably. Improved medical facilities in the form of government-run hospitals and dispensaries, research councils, and primary health centres for rural areas are also being provided.

Ocean Development

India has many interests in the field of ocean development, such as, exploration of offshore oil, fishery resources to increase food supplies, etc. A department of Ocean Development was established in 1981, under the charge of the Prime Minister, to coordinate and direct India's activities in the field of ocean research. This department has two vessels ORV Sagar Kanya and FORV Sagar Sampada, which have advanced facilities for working in the field of physical, chemical, biological, geological and geophysical oceanography and meteorology. India's achievements during the past few years include sea-bed mining using the research ship Gaveshna and setting up of research station named Dakshin Gangotri on the Antartica

Other Areas

Apart from the major areas mentioned above, India has made much progress in several other fields as well. These include the activities of the Oil and Natural Gas Commission in oil exploration and refining and of the National Committee Environment Planning in environment protection and production of solar energy. A Central Ganga Aurthority has been set up to check pollution in the river Ganga by using sewage treatment plants.

Evaluation of Progress of Science and Technology

It is clear that progress of science and technology in India has been quite significant. Many new methods, products and better quality goods have been developed in the country. India has made rapid progress in the frontier areas of science and technology like space research and atomic energy. At present the country has a strong base in modem technology. It also has the third largest scientific and technical manpower in the world.

At the same time there have been some serious shortcomings in this progress. For instance in basic products like textiles and steel, India has been importing foreign technologies. Continuous import of foreign technology shows lack of ability to create new technology to suit our needs and this creates dependence on other countries. Excessive reliance on foreign technology is also visible in the important areas of defence, where the latest weapons are often imported from other countries. Apart from this weakness in creating new technology, India has also lagged behind in developing technology to meet the needs of the poor. In the area of housing for instance, India is yet to develop, low-cost technology to meet the needs of the poor who do not have houses. Advances in the fields of nuclear and space research are praiseworthy but these have not helped the poor people so far. We may say that the progress of modem science and technology have not, as yet, benefited the people of India equally.

INTEXT QUESTIONS 14.3

1. What is science?

   _____

2. Define technology?

   _____

3. When was Department of Science and Technology set up by the Govt. of India?

   _____

4. Name the two government organisations doing research for civil and defence purposes in Science & Technology.

   _____

5. Give the name of five nuclear power stations of India.

6. When and where was Bhabha Atomic Research Centre established?

7. Which was the first Indian space satellite?

8. What were the functions of INSAT- 1B satellite?

9. How is immunisation programme beneficial?

10. Where is Dakshin Gangotri located?

11. What is the area of activity of the Department of Oceanography?

12. Which authority is working to check pollution in the river Ganga?

13. Name the national authority looking for oil exploration and refining natural gases?

14. What is the main drawback in importing foreign technology?

WHAT YOU HAVE LEARNT

- Ancient Indians made considerable scientific progress in the fields of science and technology.
- Their contribution in astronomy, mathematics, medicine, metallurgy, chemistry have made an impact on modem scientists.
- During the medieval period Indians came in contact with Arabic scientific knowledge.
- Turkish rulers and Mughals introduced gunpowder.
- Astronomical observatories were set up at Ujjain, Varanasi, Mathura, Jaipur and Delhi.
- In modem India scientific development has been duly recognised by the government and is being implemented through the Five Year Plan.
- Nuclear energy is being used for peaceful purposes as well.

- The Indian space programme is directed towards the goal of self-reliance and national development.

TERMINAL EXERCISE

1. Discuss the metallurgy capabilities of the people of the Ancient India?
2. Describe the two inventions in the field of chemistry during medieval period?
3. Describe the progress made by India in the field of medicine and health services?
4. State the applications of Science and Technology in the field of agriculture and its allied products?
5. How did rich scientific heritage acts as an asset in the modern Indian science progress?

ANSWERS TO INTEXT QUESTIONS

14.1

1. Developing science reduces our dependence on nature.
2. He deviated from Vedic astronomy and gave it s scientific outlook.
3. Apastamba was a second century BC mathematician. He introduced practical geometry involving acute, obtuse, right angles.
4. (a) Notation system

   (b) Decimal system

   (c) Use of zero
5. Charaksamhita
6. 121 surgical instruments
7. Charaksamhita and Sushrutsamhita
8. 760 plants.

14.2

1. Besides manufacturing of goods, they also provided technical and vocational training to young men.
2. Hamsa Deva
3. Nasiruddin
4. Faizi

5. Akbar
6. It was preserved on palm leaves in South India. In Kashmir, literature was preserved on birch-bark (bhoj patra)
7. Tuzuk-i-Baburi
8. The attar of roses
9. About regulations of the perfume office of Akbar.
10. 5 Delhi, Ujjain, Varansi, Mathura, Jaipur
11. Mahendra Suri, a court astronomer of Firoz Shah
12. An astronomical instrument
13. The Unani Tibb
14. It dealt principally with a host of mineral medicines including metallic preparations.
15. Tobacco, chillies, potato, guava, custard apple, cashew and pineapple.

14.3

1. It can be defined as any systematic activity that seeks to gain knowledge about the physical world.
2. Activity which seeks to put the knowledge of science into productive use.
3. 1971
4. CSIR Council for Scientific and Industrial Research

   DRDO Defence Research and Development Organisation
5. Tarapur (Maharashtra), Kota (Rajasthan), Kalpakkam (Tamil Nadu), Narora (UP), Kakrapar (Gujarat)
6. In 1971, at Trombay
7. Aryabhatta
8. It provided radio, television, telecommunication and Meteorological services.
9. It reduces infant mortality
10. On the Antarica
11. It is working in the field of physical, chemical, biological and geophysical oceanography and meterology.
12. Central Ganga Authority
13. Oil and Natural Gas Commission
14. It shows lack of our ability to create new technology.