

Chapter-1

Bharat and Science

The entire world appears to be beautiful, orderly and uncomplicated because of the various inventions and discoveries of science. Hence we can say that it is an 'era of science'. Virtually, science is a collaborative human effort. Basically, it is the means to understand properly, the laws and resources of nature.

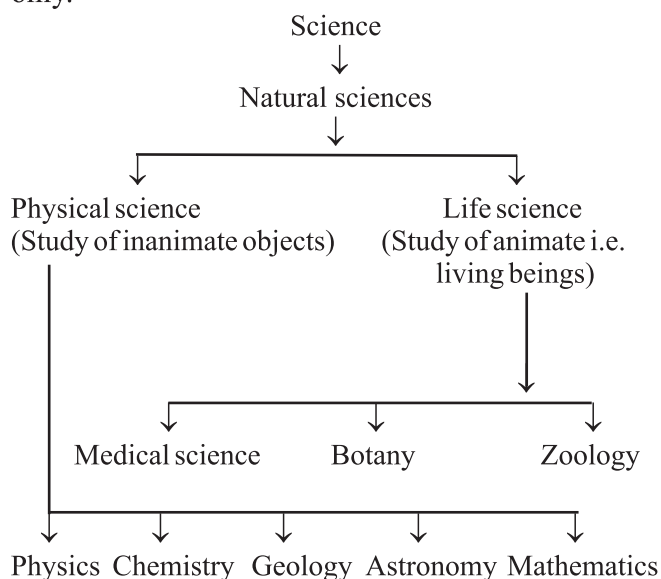
1.1 Meaning of Science :- The word "Vigyan" has been mentioned in Rig-veda. It has been derived from the sanskrit word "Vigyanam" [Vi + gya + lyu T pratyaya (i.e. verb as object)]. 'Vi' means 'specific' and 'gya' refers to 'knowledge'. Hence the word 'science' refers to 'specific knowledge. For example 'rain', it is an outcome, to experience it, is knowledge. The 'what' and 'how' of the entire process from cloud formation to the rains, is a specific knowledge and is studied under science.

The term 'science', in english, has been derived from the Latin word 'scientia' which means 'to know'. It is difficult to define science in exact words but a valid definition can be :- "The organised body of knowledge acquired by the systematic study of the structure and behaviour of the physical and natural world through observation and experiment is known as science." The prime purpose of science are as under :

- To understand the functioning of nature and to interpret it comprehensively.
- To obtain information by studying the principles of nature and validating them experimentally.
- To control nature by applying the interpretations from the observations of significant experiments.
- To use the resources available in nature for resolving problems and making human life more pleasant and of high quality.
- To know the scientific genesis (origin) of the customs and traditions prevalent in the society.

1.2 Branches of Science : Science prevails in every sphere of life. Hence efforts were made to

classify it so as to make its study convenient. At the outset it can be classified into Natural sciences, Social sciences and Technical sciences. But the nature of actual science is visible in Natural sciences only.



In order to further simplify the study of science these broad branches are sub-divided into more than 100 branches. In the current age the following contemporary branches have made special contribution to human welfare :

- Genetic engineering
- Computer science
- Information Technology
- Bio-technology

1.3 Scientific method : To think about the events occurring around us in a scientific manner is the scientific method. It has following steps :

- To identify the problem
- To formulate i.e. make a hypothesis
- To formulate a testifiable hypothesis
- To collect data
- To test the hypothesis
- To draw the result
- To re-test it
- To generalise the theory

Thus by following these steps solution to every problem can be worked out, which can be retested by anyone under the same circumstances. Considering this ideology, presenting various aspects of society and nature in a scientific manner, led to the use of the word science with certain subjects, like - Social science, Political science etc.

1.4 The Tradition of Science in Bharat :

Evidence has been found to suggest that science was thriving in this subcontinent, even in 3000 B.C. The remnants of the cities of Harappa and Mohan-jodaro, of the Indus Valley Civilisation, exhibits that these cities were well-planned and there the systems for water-supply and sewage were highly developed. They were highly efficient in agriculture, brick-construction, industries and handicrafts. Their clothes were made of cotton.

There exists evidences of 2000 B.C. which manifests the scientific temper of the Aryans. It was considered that the universe was controlled by a natural law. Each religious ritual was performed in especially constructed Temples, in accordance with the position of various celestial bodies, at auspicious moment of time. Thus they were conversant with astronomy and had knowledge of mathematics and geometry. Their almanac (an annual calender containing important dates and statistical information such as astronomical data - 'Panchang') was based on the movements of both the Sun and the Moon. They had the knowledge of various constellations and the various months were named on their basis.

The proposition that diseases were caused by the changing seasons, very minute organisms and genetic reasons, was widely accepted. The Ayurvedic system of diagnosis and treatment was prevalent. In Ayurveda was well developed. Later on, the Arabians and the Greek also adopted Ayurveda. Indian medicines were in great demand in the regions of the Roman empire.

Prior to the 18th century only seven metals were known. It was then after, that, the sequel of discovery of new elements was initiated. The seven metals, which have been mentioned in the most ancient Sanskrit literature, including Rig-Veda, Yajur-Veda and Atharv-Veda, are Gold, Silver, Copper, Iron, Tin, Lead and Mercury. The antiquity of Vedas has been resolved to be thousands of years

before Christ. Hence we can claim the existence of Chemistry in Bharat, thousands of years before Christ. Bharat has had an ancient tradition of high quality in metallurgy. This is indicated by the archeological evidences having 95 to 99% purity of various metals like Iron, Copper, Silver, Lead etc. and availability of alloys like brass.

Nalanda, Varanasi and Takshila Universities were well known in 400 B.C. Unprecedented progress was made in Mathematics, Astronomy and medical science. Sushrut had redressed the chopped nose of a patient way back in 600 B.C. (i.e. before twenty-six centuries from the present). He is known as the 'Father of Plastic Surgery' The Arabic translation of his Sushruta-Samhita is known as the Kitab Shah Shun al-Hindi or the Kitab i-Susurud.

Twenty centuries ago, Charak in "Charak Samhita" has stated "How can the physician who does not understands the body of the patient with his lamp of knowledge and understanding, cure the disease. First of all he must study all the factors affecting the patient and then proceed with the treatment. Prevention of a disease is more important than its treatment."

Rishi Kanada proposed the concept of atom in 500 B.C. In 200 B.C. Rishi Patanjali explained that in human body there are subtle (non-physical) energy channels called nadis and energy points referred to as Chakras. The eight Chakras are : Muladhaar, Svadhisthana, Manipura, Hridaya, Anahata, Vishuddhi, Ajna and Sahasrara. [i.e. 'root support', 'ones' own base', 'jewel city', 'heart', 'unstruck', 'especially pure', 'command' and 'thousand petaled']. Eight steps (charan) or positions (stithiyan) have been suggested to keep them activated. They are yamas (Universal moral ethical rules), Niyamas (Means to keep one self virtuous in a disciplined manner), Asana (postures), Pranayaam (restraining the breath) Pratyahara (bringing near one's thoughts and awareness to within i.e. divert them from external world), Dharana (concentration), Bhawana (contemplation i.e. meditation) and Samadhi, (Most animate state i.e. the spiritual state in which the mind loses the sense of its own identity). The last step is the most difficult one. In it the person feels himself to be energetic, self-controlled and filled up with capabilities.

1.5 Contribution of Bharat in the Development of Science :

Aryabhatta was the first person to state that Earth is round and it rotates on its axis which results in the formation day and night. Moon shines by the light of sun.

Brahmagupt was the mathematician who made the rules to work with zero, for the first time. The title of "Ganak Chakra Churamari" was bestowed upon by the famous mathematician Bhaskar. He gave the two branches of mathematics : Algebra and Mathematics.

The discovery made by the scientist, who provided 'new radiations' to the world, Chandra Shekhar Venkat Raman, came to be known as the 'Raman Effect'. He received the Nobel Prize in Physics in 1930. 'Raman Effect' was demonstrated by him on 28th February. This day is celebrated as National Science Day. 'Raman effect' is that amazing effect by which the nature of light changes when it passes through a transparent medium. This medium can be either solid, liquid or gas. Raman effect proved to be one more important instrument for scientists, after the invention of laser, because of its powerful light radiation.

Homi Jehangeer Bhabha explored a new particle 'Meson'. It was under his directions, that three atomic reactors, Apsara, Cirus and Zerlina, were established. One of the comets has been named bappu-bok-newkirk after the name of the first Indian astronomer MK Vainu Bappu (Manali Kallat Vainu Bappu). Jagdish Chandra Bose discovered sensations in plants.

The promoter of chemical industry in India, Prafulla Chandra Ray, discovered mercurous nitrate in 1896. His book 'The History of Hindu Chemistry' received immense reputation.

1.6 Bhartiya Scientists :

1.6.1. Birbal Sahani (1891-1949)

Dr. Birbal Sahani was born on 14 November 1891, at the home of Prof. Ruchi Ram Sahani, at Bhera, a village in Shahpura district of West Punjab (Pakistan). After his graduation from Punjab University, he obtained his B.Sc. degree from London University, Britain. He was the first Bhartiya to obtain



D.Sc. degree from Cambridge. The Royal Society of London honoured and glorified him by appointing him as its Fellow (FRS : Fellow of Royal Society). Dr. Birbal Sahni was the fifth Bhartiya to obtain this prestigious award.

Dr. Sahni was a great paleobotanist of Bharat. Study of the vegetation of the ancient era was a new science for this country. It is known as the Paleobotany.

Dr. Sahni discovered a new group of fossil plants. They are gymnosperms (naked seeded) : Pines and other trees of their species which are known as pentaxylales. This attracted the attention of the entire world. The theory of sliding of continents away from each other was authenticated by his paleobotanical studies. According to this theory the continents keep on sliding on the earth surface like a boat glides on the surface of water of a river.

Dr. Sahni researched on the living vegetation for the first time. Then, he again explored the traces of Bhartiya vegetation. He investigated many remnants of Bhartiya vegetation and published their detailed descriptions in 'Philosophical Transaction' and many other journals. Other researches made by him - Theory of Continental Division, Age of the Southern Plateau, Himalayan upliftment after the origin of Glossopteris vegetation etc. - were helpful in solving many complex systems. The Birbal Sahni Institute of Paleobotany, established by him, is the first institute of its sought.

1.6.2. Meghnad Saha (1893-1953)

Meghnad Saha was borne on 6th October, 1893 at the home of Jagannath Saha and Bhuvneshwari Devi in the Seoratali village, in the Dhaka district of Eastern Bengal (Bangladesh). Full of love for his nation, at the age of thirteen years Saha along with three other students was rusticated from the school since he had taken a leave as a protest against the welcome ceremony being organized for the Governor Sir Bamfylde Fuller and instead, participating in the strike against the Bengal partition. He had to pay a heavy price. He was deprived of his scholarship and had to take



admission in a private school by giving more fee. He did his M.Sc. in Mathematics from Calcutta University. Sharat Chandra Bose and Netaji Subhash Chandra Bose were three years junior to him. His teachers were Sir Jagdish Chandra Bose, Sir Prafulla Chandra Ray and D.N. Mallik.

In those days Thermodynamics, Relativity and atomic theory were the new themes in physics. Saha read many books on these subjects and taught very well. While reading and preparing notes on Agnes Clerke's book, about Sun and Stars, he faced problems regarding the temperature of the stars, their internal structure, organisation and the phenomenon when sunlight passed through water drops or prism, forming a spectrum.

As a solution to these problems, Saha proposed the ionisation formula, which can be used to explain the presence of spectral lines. With the help of this formula astronomers are able to find out the temperature, pressure and internal structure of the Sun and other stars. It was a big discovery in the field of Stellar physics.

The temperature, internal structure and organisation of the stars etc. are studied under Astrophysics.

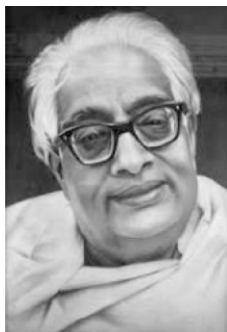
He established the Saha Institute of Nuclear Physics and got the first Cyclotron of Bharat.

After studying the reasons of floods he suggested many river valley projects, including the Damodar Valley, Bhakra Nangal and Hirakud.

1.6.3 Professor Satyendra Nath Bose (1894-1974)

Satyendra Nath Bose was born on 1 January 1894 in the home of father, Surendra Nath Bose and mother, Amodini Devi. He did his M.Sc. in Physics from Kolkata University. He worked with Madame Curie and Albert Einstein.

According to the amendment done by Bose, the initial statistical methods of Maxwell and Boltzmann's 'kinetic molecular theory' could also be applied to photons and electrons. Bose's modified demonstration became famous by the name of 'Bose- Einstein statistics'. Presently, there are two statistical methods for analysis of the array of initial particles, which have divided all the



particles into two parts : boson and Fermion. This classification is based on the spinning quality of the particles.

American scientist Enrico Fermi established that the spin quantum number of particles like electron, proton, neutrino, neutron etc, rotating on their axis, is a complete multiple of half; i.e. half, one and a half, two and a half etc. These particles were named after him as Fermion. Indian scientist Satyendra Nath Bose found that the spin quantum number of particles like photons, pi-meson, alpha particles, gravitons etc is an interger i.e. zero, one, two, three etc. These particles were named Bosons after him.

The fifth form of matter has been named as the Bose-Einstein condensate (B.E.C.). BEC is prepared by cooling a gas having density as low as one lakh part of that of the normal air, at very low temperature.

Working in the sphere of chemistry he prepared a chemical by bringing about internal changes in the atom of sulphonamide, which, till date is prevailing in the form of eye-drops.

His dedication for hindi language is obvious by his statement "So, in this country there are people who do not like the language in which their mother sung lullabies for them and instead, like the language in which foreigners have rebuked them." S.N. Bose was a member of Rajya Sabha also.

1.6.4 Bhaskaracharya First (600 BC - 680 BC)

Bhaskaracharya I was born at Bori village, in Parbhani district of the state of Maharashtra in 7th century.

Bhaskaracharya I was the first mathematician to write numbers according to the Hindu decimal system. The numbers were written in words or analogy i.e. symbol and not in figures. For example moon for one; pair, wings or eyes for two since they always occur in pair; the five sense organs for number five etc.

Aryabhatiya-bhashya is the oldest prose work in sanskrit on mathematics and astronomy. It was written in 429 century. Bhaskaracharya I wrote two texts named Mahabhaskariya and Laghubhaskariya. Later on they were translated in Arabic also.

In Mahabhaskariya text a rational expression to express the value of trigonometric

function $\sin x$ has been given. This formula is attractive and easy and a sufficiently abstract value of $\sin x$ is obtained.

$$\sin x \approx \frac{16x (\pi-x)}{5\pi^2-4\pi (\pi-x)}$$

$$0 \leq x \leq \frac{\pi}{2}$$

This formula is said to be stated by Aryabhata. In it the relative error of the values of $\sin x$ is less than 1.9%. Maximum deviation being

$$\frac{16}{5\pi} - 1 \approx 1.859\%$$

which is at $x = 0$.

Bhaskaracharya I made a statement for prime number P that $1 + (P-1)$ is divisible by P . Later on it was proved by Al - Haitham and also Fibonacci. Now-a-days it is referred to as the Wilson's theorem.

Bhaskaracharya I stated a theorem, $8x^2-1=y^2$, which is now known as the Pell equations. Here Bhaskaracharya I raised a query "Tell the numbers whose square when multiplied by 8 and 1 is added to the product, gives the square of another number."

For example in $8x^2+1=y^2$, if $x=1$ then $y=3$. This is written in short as $(x, y) = (1, 3)$. Similarly $(x, y) = (6, 17)$.

In ancient Bharat many such great scientists, philosophers and mathematicians were there whose investigations are very important for the modern world formations and have proved to be the milestones.

1.7 Scientific achievements of Contemporary

Bharat : Achievements of Bhartiya scientists are there in various spheres. If the supreme award, Nobel Prize is regarded, the recipients include : C.V. Raman in 1930, Har Govind Khurana in 1983, Venkatraman Ramakrishnan in 2009. Some of the articles developed and invented in Bharat are as follows :

Button, Kajal, Chess, Calico, Crescograph, Crucible, Steel, Ruler, Shampoo, Indigo dye, Refinement of sugar, Test-tube baby etc.

The first underground atomic testing was successfully accomplished by Bharat at Pokran in 1974 and the second test was conducted at Khetolai. In 1975, Bharat's first artificial satellite Aryabhata was launched.

Satellite named Rohini was launched by Indian Space Research Organization (ISRO) using the launch vehicle SLV-3, that was made in Bharat. GSLV-DS which uses indigenous Bhartiya Cryogenic engine was launched in 2014.

Bharat's first mission to Moon, Chandrayaan-1, was launched on 22 October 2008. By finding water in lunar environment for the first time, this mission, Bharat has registered its forceful presence in the present era.

The Mass Orbital Mission was launched on 24 September, 2014.

On 16 December 2015, ISRO successfully demonstrated its ability to deploy multiple satellites in different orbits, on same flight, by using PSLV C-29, which was launched from Satish Dhawan Space Centre, Sriharikota.

Inspired by the Bhartiya Yog Darshan, UNO decided to celebrate 21 June as International Yog Day, all over the world. It is a matter of Pride for Bharat.

Thus, Bharat has demonstrated its role in many sphere of science. Many Bhartiyas working from various places all over the world are benefitting the entire globe with their knowledge.

Still there is immense potential of inventions and discoveries in the latest domains of science, hence the bhartiyas must come forward in this direction.

IMPORTANT POINTS

1. The knowledge acquired by the systematic study of nature and validated by experimentation is known as science.
2. Selection of a problem, making a hypothesis, testing it, obtaining result from it and generalising it by making theory; is the scientific method.
3. The Harappa and Mohan-jo-daro civilisations of 3000 BC are the evidence of the developed Bhartiya science.
4. The father of plastic surgery, Sushrut, had healed a damaged nose, 26 centuries ago.
5. 200 years before christ (BC) the sage Patanjali's

- Yog Darshan was prevalent for healthy life.
6. Brahmgupt who provided information about zero was a Bhartiya Mathematician.
 7. C.V. Raman was given the Nobel Prize in 1930 for the discovery of Raman Effect.
 8. Birbal Sahani was a paleobotanist.
 9. Meghnad Saha provided information about astrophysics.
 10. A theorem given by Bhaskaracharya I is currently in practice by the name Pell's equation.

Questions Objective Questions

- Q.1 Which substance was discovered by Prafulla Chandra Roy, the promoter of chemical industry in Bharat?
(a) Sodium chloride
(b) Mercurous nitrate
(c) Sulphuric acid
(d) Ammonium chloride
- Q.2 Birbal Sahni was related to which sphere of science?
(a) Chemistry
(b) Paleobotany
(c) Physics
(d) Computer Science
- Q.3 The name of first Bhartiya scientist to work in the domain of astrophysics is :
(a) Birbal Sahni
(b) Satyendra Nath Bose
(c) Einstein
(d) Meghnad Saha
- Q.4 Bharat's first mission to moon 'Chandrayaan-1' was launched on which date ?
(a) 22 October 2008
(b) 5 November 2013
(c) 15 August 2015
(d) 28 February 2015
- Q.5 Who is known as the Father of Plastic Surgery?
(a) Charak (b) Sushrut
(c) Kanad (d) Patanjali

Very Short Answer type Question :

- Q.6 Give the name of the text composed by Sushrut.
- Q.7 To which mathematician was the title of 'Ganak Chakra Chudamani' given, by

- Brahmgupt?
- Q.8 When is the National Science Day Celebrated?
 - Q.9 Who wrote the book "The History of Hindu Chemistry"?
 - Q.10 By what name, is the branch of science which deals with the study of vegetation of the past era, known as?
 - Q.11 Which scientist gave the ionization theory in Physics?
 - Q.12 Under the supervision of which scientist was the first cyclotron in Bharat inducted?
 - Q.13 Give the name of the Bhartiya scientist who gave the 'Bose Einstein Statistics'.
 - Q.14 When is the World Yog Day celebrated?
 - Q.15 When was the Mass Orbiter Mission launched?

Short Answer Type Questions :

- Q.16 Write the two important works accomplished by Bhaskaracharya I.
- Q.17 Which substance was used by Prof. Satyendra Nath Bose to prepare eye drops?
- Q.18 What are bosons?
- Q.19 How is the 'Bose-Einstein condensate' obtained?
- Q.20 What is 'Roman Effect'?
- Q.21 What is studied under astrophysics?
- Q.22 Which three atomic reactors were established by Homi Jehangir Bhabha?
- Q.23 Name the Arabic translation of Sushrut Samhita.
- Q.24 Write the names of the three main branches of biology.
- Q.25 Define science.

Essay type Questions:-

- Q.26 Write the different steps of scientific methods.
- Q.27 Name the eight stages of yoga as given by Patanjali.
- Q.28 The researches done by Dr. Birbal Sahni proved helpful for which spheres of science?

Answer key

- 1 (b) 2 (b) 3 (d) 4 (a) 5 (b)