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## SCIENTISTS OF MODERN INDIA

The development of scientific thought in modern India can be attributed to the scientists of this period. Towards the second half of the nineteenth century, Sir C.V. Raman brought about an unprecedented change in Indian scientific thought, Dr. Homi J. Bhabha, known as the father of our Nuclear Physics, predicted the future of Indian science. Dr. J.C. Bose, in the field of plant physiology, Dr. Vikram Sarabhai, in the field of atomic energy and industrialization and Dr. Abdul Kalam, in the field of defence technology, brought about revolutionary changes to reawaken the glory of Modern India



### OBJECTIVES

After reading this lesson you will be able to :

- *enumerate the important achievements of some of the great Indian scientists of modern times: and*
- *enlist their contributions to the service of human society.*

### 17.1 SRINIVAS RAMANUJAN (1887-1920)

Srinivasa Aiyangar Ramanujan (FRS) better known as Srinivasa Iyengar Ramanujan, one of India's greatest mathematical genius, was born at Erode in Tamil Nadu on 22 December, 1887. Later on, his parents shifted to Kumbakonam, 160 kilometres from Chennai. Ramanujan studied at the Town Hall School in Kumbakonam, where he proved himself to be an able all-rounder. However, his love of mathematics was unusual. Numbers seemed to draw him by a strange magnetism. In school itself at the age of thirteen, he came across a book called *Synopsis of Elementary Results in Pure Mathematic* by G. S. Carr. Though outdated, this book introduced him to the world of mathematics. He started working

and developing his own ideas in mathematics. He used to write his ideas and results and make notes on his findings.

Three of his research note books are available to us. They are called Ramanujan's Frayed Notebooks. He could not complete his college education as he kept on developing his ideas and started posing problems and solving them in the *Journal of Indian Mathematical Society*. In 1911, he published in the same journal a brilliant research paper on Bernoulli Numbers. This got him recognition and he became well known in Madras circles as a mathematical genius.

Lack of formal education made it very difficult for him to make both ends meet. With great difficulty he could get the job of a clerk at Madras Port Trust which proved fortunate for him. Here he came in contact with many people who had training in mathematics. He found a book '*Orders of Infinity*' written by G. H. Hardy. He wrote a letter to him in which he mentioned 120 theorems and formulae. Hardy was quick to recognise his genius and he responded by arranging for him a passage to London. Despite his lack of required qualification he was allowed to enroll at Trinity College from where he got his Bachelor of Science degree in less than two years. He formed a wonderful team with Hardy and J.E. Littlewood and made amazing contributions to the field of mathematics. He published many papers in London. He was the second Indian to be elected Fellow of the Royal Society of London and the first Indian to be elected Fellow of Trinity College.

Ramanujan had an intimate familiarity with numbers. In 1917, he fell seriously ill, but the numbers remained his friend, though his body betrayed him. Unfortunately, his health became worse and he returned to India in 1919, "With a scientific standing and reputation". He died in 1920. His mathematical genius is a proof that India indeed is the birthplace and source of great mathematical ideas.



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## 17.2 CHANDRASEKHARA V. RAMAN (1888-1970)

Chandrasekhara V. Raman, popularly known as C.V. Raman, was not only a great scientist but also believed in the promotion of human well being and human dignity. He won the Nobel Prize for Physics in 1930. He was the first Asian to receive this award.

C.V. Raman was born on 7 November 1888 in Tiruchirapalli, in Tamil Nadu. His father was a professor of Physics and Mathematics. He grew up in an environment of Sanskrit literature, music and science. Nature had gifted him with great power of concentration, intelligence and spirit of inquiry. Even in his childhood, he was popular as a child genius. He stood first in the Indian Audit and Accounts (IAAS) Examination and was appointed as Assistant Accountant General in the Finance Department in Calcutta at the age of nineteen. He sacrificed his high post for his love for science and joined the Science College of Calcutta University as a professor of Physics. Due to his deep love of music, he started working on musical instruments like the veena, violin, tabla and mridangam. In 1921, he



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read a paper on the theory of Stringed Instruments before the Royal Society of London. In 1924, he was made Fellow of the Royal Society.

On his journey to England, he was greatly attracted by the blue colour of the sea. He was curious to know why it remained blue even when big waves rolled up. Then he got the intuitive flash that it was due to the breaking up of sun's light by water molecules. He conducted many experiments and prepared a long paper on molecular scattering of light and sent it to the Royal Society of London. The world of science was dumb struck at the brilliance of his mind.

**Raman Effect**

When a beam of monochromatic (having single colour) light passes through a transparent substance, it scatters. Raman studied the broken light. He found that there were two spectral lines of very low intensity (strength) parallel to the incident monochromatic light. This showed that broken light was not monochromatic, though the incident light was monochromatic. Thus a great phenomenon hidden in nature was revealed to him. This phenomenon became famous as Raman Effect and spectral lines in the scattered light as Raman Lines. While scientists had been debating over the question whether light was like waves or like particles, the Raman Effect proved that light is made up of particles known as photons.

Dr. Raman was a great teacher and a great guide as well. He generated immense confidence among his students. One of his students was in very low morale because he had only one kilowatt powered X-Ray equipment, whereas a scientist in England was working with 5 kilowatt powered X-Ray equipment. Dr. Raman inspired him to use his 10 kilowatt powered brain instead.

Dr. Raman's life is a great example for us to follow. Even when India was under British rule and there was hardly any basic infrastructure for experimentation, he used his great mind as his laboratory. He proved through the example of his life, how our ancestors formulated great theories using the power of their mind.

**17.3 JAGDISH CHANDRA BOSE 1858-1937**

J.C. Bose another great scientist of modern India brought glory and respect for the country. He was born on 30 November, 1858 at Mymensingh, now in Bangladesh, where he had his early education. He had his higher education at St. Xavier's College, Calcutta. In 1885 he was appointed Assistant Professor of Physics at the Presidency College but refused to take salary because it was nearly half of that of an Englishman. Later on, he decided to become a scientist to recover the fame that India enjoyed all over the world in ancient times. He made an apparatus to study the properties of electric waves. For his paper on "The Electromagnetic Radiation and Polarization of Electric Ray", he was made a Knight

in 1917 and Fellow of the Royal Society of London in 1920. He was the first Indian scientist in Physics to receive this honour.

Dr. Bose is famous all over the world as the inventor of Crescograph that can record even the millionth part of a millimeter of plant growth and movement. Dr. Bose proved through graphs taken by the Crescograph that plants have a circulatory system too. Crescograph has also shown that the upward movement of sap in plants is the activity of living cells.

Dr. Bose also made many other instruments famous all over the world as Bose instruments, to prove that even metals react to outward stimuli. Bose's instruments have shown, how even steel and metals used in scissors and machinery get tired and regain efficiency after a period of rest.

Besides Crescograph and other Bose instruments, his wireless inventions too antedated those of Marconi. He was the first to invent a wireless coherer (radio signal detector) and an instrument for indicating the refraction of electric waves. When someone drew his attention towards this fact, he simply remarked that it is an invention which is more important for mankind than the inventor.

**INTEXT QUESTIONS 17.1**

1. Who is called the father of nuclear physics in India?  
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2. Srinivasa Ramanujan excelled in which field?  
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3. Which work of Ramanujan Srinivasa was published in the Journal of Indian Mathematical Society?  
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4. Who wrote the Orders of Infinity?  
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5. When did C.V. Raman win Nobel prize for physics?  
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6. What attracted the most to C.V. Raman during his journey to England?  
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7. Which paper was written by C.V. Raman and sent to Royal Society of London?  
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**Notes**



## Notes

8. What is called Raman Effect?

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9. What are photons?

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10. What work of Jagdish Chandra Bose gave him Knight position in London?

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11. Who invented Crescograph?

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12. What does a Crescograph record?

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13. Who invented the first wireless coherer?

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### 17.4 HOMI JEHANGIR BHABHA (1909-1966)

Dr. Homi Jehangir Bhabha was a great scientist. He led India into atomic age. He is called the father of Indian Nuclear Science. He was born on 30 October, 1909 in a famous Parsi family. Even as a boy, he showed his intelligence and won many prizes. He did his early studies in Mumbai. He took a degree in Mechanical Engineering in First Class from Cambridge, completed research work there and received his doctorate in 1935. Till 1939, he carried outstanding original research relating to cosmic radiation. He returned to India when the Second World War started.

Dr. Bhabha joined the Indian Institute of Sciences at Bangalore as a Reader at the request of Dr. C.V. Raman. Soon he became a Professor of Physics. It was here that he got the idea of building a research institute for some of the new areas of Physics. He took a very bold decision and wrote a letter to Sir Dorab Ji Tata suggesting that an institution should be established which would lay the foundation of India as a world nuclear power. This institute would produce its own experts and the country would not have to depend on outside sources. As a result, Tata Institute of Fundamental Research (TIFR) was started in 1945, at Dr. Bhabha's ancestral home.

India's first atomic research centre now called Bhabha Atomic Research Centre (BARC) was established at Trombay. India's First atomic reactor, Apsara was also established under his expert guidance. Bhabha became the first chairman of the Atomic Energy Commission set up in 1948. His studies in the field of atomic energy are considered of great importance in international circles. He served as the chairman of international



conference on peaceful uses of atomic energy, supported by the United Nations. The Government of India honoured him with Padma Bhushan. In 1966, Dr. Bhabha died in a plane crash.

### **17.5 DR. VIKRAM AMBALAL SARABHAI (1919-1970)**

Dr. Vikram Ambalal Sarabhai is another great genius of modern India. He was the main personality behind the launching of India's first satellite Aryabhata. He received his primary education at a school run by his parents. He studied cosmic rays under the guidance of Dr. C.V. Raman and received his Ph.D. degree from Cambridge University. His studies of cosmic rays have made it clear that cosmic rays are a stream of energy particles coming from the outer space. While reaching the earth, they are influenced on the way by the sun, the earth's atmosphere and magnetism.

Dr. Sarabhai had a multifaceted personality. He was a great industrialist. Today, there are many industries founded by him such as Sarabhai Chemicals, Sarabhai Glass, Sarabhai Geigy Ltd., Sara Bhai Merck Ltd. and many others. He also helped in saving crores of rupees for India by starting the mission of manufacturing military hardware and producing antibiotics and penicillin in India which were being imported from abroad. He was also the founder of Ahmedabad Textile Industrial Association and Ahmedabad Money Association. In this way, he established a large number of successful industries.

Dr. Vikram Ambalal Sarabhai established many institutes which are of international repute. Most notable among them are Indian Institutes of Management (IIMS) which are considered world class for their management studies.

He was the Chairman of the Indian National Commission for Space Research (INCOSPAR) and of the Atomic Energy Commission. He directed the setting up of Thumba Equatorial Rocket Launching Station (TERLS). He also made plans to take education to the villages through Satellite communication. He was awarded the Padma Bhushan in 1966 and the Padma Vibhushan after his death. His death was a great loss to the nation.

### **17.6 DR. A.P.J. ABDUL KALAM**

Dr. A.P.J. Abdul Kalam, the eleventh President of India was born on 15 October, 1931, in the island town of Rameshwaram, in Tamil Nadu. He was awarded the Bharat Ratna, India's highest civilian honour in 1997 for his contributions in the field of science and engineering.

Dr. Kalam had his primary education at Rameshwaram. He passed his class ten exams from Schwartz High School, Ramanathapuram and obtained a degree in Aeronautical Engineering from Madras Institute of Technology.



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Dr. Kalam served in Indian Space Research Organisation (ISRO) from 1963 to 1982. At Vikram Sarabhai Space Centre, he developed the Satellite Launch Vehicle (SLV 3), which put the satellite Rohini into orbit. In 1982, as Director, Defence Research Development Organisation (DRDO), he was given the responsibility of Integrated Guided Missile Development Programme (IGMDP). He developed five projects for defence services - Prithvi, Trishul, Akash, Nag and Agni. He led India into an era of self-dependence. Agni, which is a surface to surface missile, is a unique achievement. Its successful launch made India a member of the club of highly developed countries. The light weight carbon material designed for Agni has been used to make calipers for the polio-affected. The material has reduced the weight of calipers to 400 grams from 4 kgs. It is a great blessing for human beings. The material has also been used for making spring like coils called stents, which are used in Balloon Angioplasty for treating heart patients.

Dr. Kalam's life is a symbol of the true spirit of India. He is a real follower of Indian tradition and religion. He has integrated science with religion and philosophy. He strongly believes in being guided from inside i.e. "relying more on inner signals and less on external cues" as well as doing duties selflessly. Dr. Kalam says, "I have no belongings in the worldly sense. I have acquired nothing, built nothing, possess nothing, no family, sons, daughters."



## INTEXT QUESTIONS 17.2

1. What was the research work of Dr. Homi J. Bhabha?

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2. Which institution was opened at Dr. Bhabha's ancestral home in 1945?

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3. What was the name of the first Atomic Reactor?

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4. What are cosmic rays?

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5. How did Dr. Vikram Sarabhai able to save crores of Indian rupees?

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6. What is TERLS?

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7. Name the projects for defence services developed by Dr. A.P.J. Abdul Kalam.

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8. How did Dr Abdul Kalam help polio-affected people?

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### WHAT YOU HAVE LEARNT

- Srinivasa Ramanujan was a great mathematical genius of India who has several outstanding achievements in this field to his credit.
- C.V. Raman was an outstanding Indian scientist who won the Nobel Prize for Physics in 1930. His finding that light is made up of particles known as photons is known as the Raman Effect.
- Dr. J.C. Bose is credited with the invention of the Crescograph that can record plant growth and movement, among other achievements, like devising instruments known as Bose instruments.
- Dr. Homi Bhabha was another great Indian Scientist who led India into the atomic age.
- Dr. Vikram Sarabhai was another great genius of modern India who was behind the launching of India's first satellite Aryabhata. He was also a great industrialist who founded many industries. He was the chairperson of INCOSPAR and the Atomic Energy Commissions.
- Dr. A.P.J. Abdul Kalam, the President of India, developed the SLV3 which put the satellite Rohini into orbit. As Director of DRDO, he developed five projects - Prithvi, Trishul, Akash, Nag and Agni. He continues to inspire the Indian youth till today.



### TERMINAL EXERCISE

1. Describe the contributions of Jagdish Chandra Bose in the field of science and Technology.
2. Elaborate the efforts of Dr. Homi J. Bhabha in building India a super nuclear power.
3. How was C.V. Raman able to prove that our ancestors formulated great theories using the power of their mind?
4. Dr Kalam's life is a symbol of the true spirit of India. Discuss.



**Notes**





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## ANSWERS TO INTEXT QUESTIONS

## 17.1

1. Homi J. Bhabha
2. Mathematics
3. A research paper on Bernoulli numbers.
4. G.H. Hardy
5. In 1930
6. Blue colour of the sea
7. One molecular scattering of light
8. In the broken light, there were two spectral lines of low intensity parallel to the incident monochromatic light. This showed that the broken light was not monochromatic though the incident light was monochromatic.
9. Particles that together make light
10. His paper on the Electromagnetic Radiation and polarization.
11. Jagdish Chandra Bose
12. The millionth part of a centimeter growth of a plant and its movement.
13. Jagdish Chandra Bose

## 17.2

1. Cosmic Radiation
2. Tata Institute of Fundamental Research (TIFR).
3. Apsara
4. Cosmic rays are a stream of energy particles coming from the outer space.
5. He started the manufacturing of military hardware and producing antibiotics and penicillin in India.
6. Thumba Equatorial Rocket Launching Station
7. Prithvi, Trishul, Akash, Nag, and Agni
8. He reduced the weight of calipers from 4 kgs to 400 gms only.