

**Question 1.**

Some of the most profound statements on the nature of science have come from Albert Einstein, one of the greatest scientists of all time. What do you think did Einstein mean when he said :”The most incomprehensible thing about the world is that it is comprehensible”?

**Answer:**

The physical world, when seen by a layman, presents us with such a wide diversity of things. It seems incomprehensible, i.e., as if it cannot be understood. On study and analysis, the scientists find that the physical phenomena from atomic to astronomical ranges can be understood in terms of only a few basic concepts, i.e., the physical world becomes comprehensible. This is what is meant by Einstein’s statement made above.

**Question 2.**

“Every great physical theory starts as a heresy and ends as a dogma”. Give some examples from the history of science of the validity of this incisive remark.

**Answer:**

Anything against the established belief is called heresy and an established belief, which is questioned by only a few is called dogma.

Since the earliest of times, the motion of planets has been the subject of attention for the astronomers. The physical theory for the planetary motion started as a heresy and ended as a dogma.

About 2,000 years ago, Ptolemy proposed the geocentric model for the planetary motion, according to which the stars, the sun and all the planets revolved around the stationary earth. A thousand years later, a Polish monk Nicolas Copernicus proposed heliocentric model for the planetary motion, according to which all the planets along with the earth revolved around the stationary sun. His theory was discredited by the Pope as this concept was considered to be against the religious belief. The Italian scientist Galileo, who supported this theory, was even prosecuted by the state authorities. Today, it is a well settled theory.

**Question 3.**

“Politics is the art of the possible”. Similarly, “Science is the art of the soluble”. Explain this beautiful aphorism on the nature and practice of science.

**Answer:**

Nothing is impossible in politics and the politics is the art of possible. It is a well known fact that to win over votes, politicians make anything and everything possible even when they are least sure of the same. In politics, ministry may change overnight, but in science universal laws do not change overnight. Science is a systematised study of observations. A scientist patiently analyses these observations and comes out with certain laws. e.g. Tycho Brahe worked for twenty long years to make observations on planetary motions. J. Kepler formulated his three famous laws of planetary motion from this huge reservoir of observations. Thus the statement that science is the art of the soluble means that a wide variety of physical processes are understood in terms of only a few basic concepts, i.e. there appears to be unity in

diversity as if widely different phenomena are soluble and can be explained in terms of only a few fundamental laws. Newton's laws of gravitation are applicable throughout the universe. They are same for two small bodies as well as for the solar system. Whole of the universe can be dissolved into certain laws i.e. we can study the universe on the basis of a few laws.

**Question 4.**

Though India now has a large base in science and technology, which is fast expanding, it is still a long way from realising its potential of becoming a world leader in science. Name some important factors, which in your view have hindered the advancement of science in India.

**Answer:**

**In my view, some important factors which have hindered the advancement of science in India are :**

1. Lack of education,
2. Poverty, which leads to lack of resources and lack of infrastructure,
3. Pressure of increasing population,
4. Lack of scientific planning,
5. Lack of development of work culture and self discipline.

**Question 5.**

No physicist has ever "seen" an electron. Yet, all physicists believe in the existence of electrons. An intelligent but superstitious man advances this analogy to argue that 'ghosts' exist even though no one has 'seen' one. How will you refute his argument?

**Answer:**

The existence of an electron is a fact though nobody has ever seen as electron because many phenomena have been actually observed in our daily life which depend upon the existence of an electron. On the other hand, ghosts are also not seen but there is not a single phenomenon which can explain the existence of ghosts and there is no phenomenon which can be explained on the basis of the existence of ghosts. Hence clearly, the comparison between the two cases is meaningless.

**Question 6.**

The shells of crabs found around a particular coastal location in Japan seem mostly to resemble the legendary face of a Samurai. Given below are two explanations of this observed fact. Which of these strikes you as a scientific explanation?

**(a)** A tragic sea accident several centuries ago drowned a young Samurai. As a tribute to his bravery, nature through its inscrutable ways immortalised his face by imprinting it on the crab shells in that area.

**(b)** After the sea tragedy, fishermen in that area, in a gesture of honour to their dead hero, let free any crab shell caught by them which accidentally had a shape resembling the face of a Samurai. Consequently, the particular shape of the crab shell survived longer and therefore in course of time the shape was genetically propagated. This is an example of evolution by artificial selection.

**Answer:**

**Explanation:** **(b)** is a scientific explanation of the observed fact.

**Question 7.**

The industrial revolution in England and Western Europe more than two centuries ago was triggered by some key scientific and technological advances. What were these advances?

**Answer:**

**The following are the key scientific and technological outstanding contributions that triggered industrial revolution in England and Western Europe during that period i.e. from 1750 A.D. to 1870 A.D:**

- (1) Steam engine formed on the application of heat and thermodynamics. British inventor, James Watt in 1769 A.D. invented it and it made possible setting of industries in interior of country, far away from river bank. Machines were then driven by steam power.
- (2) Blast furnace which converts low grade iron into steel cheaply.
- (3) Cotton gin or spinning genny which separates the seeds from cotton three hundred times faster than by the hand.
- (4) Discovery of electricity helped in designing dynamos and motors.
- (5) Discovery of explosives not only helped army but also mineral exploration.
- (6) Study of motion and making guns/ canons was led by the study of gravitation.
- (7) Invention of power loom which used steam power was used for spinning and weaving.
- (8) Safety lamp which was used safely in mines.

**Question 8.**

It is often said that the world is witnessing now a second industrial revolution, which will transform the society as radically as did the first. List some key contemporary areas of science and technology, which are responsible for this revolution.

**Answer:**

**Following are some contemporary areas of science and technology, which ' may be responsible for a second industrial revolution:**

1. Developing superconducting materials at room temperature, so that transmission of electrical energy may be made without any loss of energy.
2. Advancement in biochemistry, as that new safe drugs in place of steroids may be developed.
3. Advancement in biotechnology, so as to develop alternative energy resources.
4. Developing robots, so that the tasks which involve risk to human lives may be accomplished safely and efficiently.
5. Developing superfast computers, so that data may be transferred from one place to the other at a faster rate.
6. Further advancement in information technology.

**Question 9.**

Write in about 1000 words a fiction piece based on your speculation on the science and technology of the twenty-second century.

**Answer:**

Imagine a space ship heading towards a star about 100 light years away. It is propelled by electric current generated by electromagnetic induction, as the space ship crosses the magnetic fields in space.

The current is given to an electric motor made of superconducting wires. Thus, no energy would be required to propagate the space ship over its entire journey.

In a particular region of the space, suppose the temperature becomes so high that the superconducting property of the wires of the motor is destroyed. This causes a panic in the space ship because no power is generated by the motor.

In a split second, another space ship filled with matter and antimatter stored in different compartments to produce energy for the first ship comes to its rescue. And the first ship continues its onward journey.

#### **Question 10.**

Attempt to formulate your 'moral' views on the practice of science. Imagine yourself stumbling upon a discovery, which has great academic interest but is certain to have nothing but dangerous consequences for the human society. How, if at all, will you resolve your dilemma?

#### **Answer:**

A scientist aims at truth. A scientific discovery reveals truth of nature. Thus, any discovery good or bad for human society must be made public, although moral and ethical values may have a conflict with the practice of science. A discovery which appears dangerous today may become useful to mankind sometimes later. We must build up a strong public opinion in order to prevent the misuse of scientific technology.

#### **Thus scientists in fact should take up two roles:**

- (1) to discover truth and make it public.
- (2) to prevent its misuse, e.g. cloning of animals like sheep 'Dolly' is applied to mankind then it will be against ethical values as it will require no man and woman for recreation. But as a scientific truth it is made public. If I stumble on such a thing as a scientist. I will least bother about morality and keep on the truth to become public.

#### **Question 11.**

Science, like any knowledge, can be put to good or bad use, depending on the user. Given below are some of the applications of science. Formulate your views on whether the particular application is good, bad or something that cannot be so clearly categorised:

- (a) Mass vaccination against small pox to curb and finally eradicate this disease from the population. (This has already been successfully done in India).
- (b) Television for eradication of illiteracy and for mass communication of news and ideas.
- (c) Prenatal sex determination
- (d) Computers for increase in work efficiency
- (e) Putting artificial satellites into orbits around the Earth
- (f) Development of nuclear weapons
- (g) Development of new and powerful techniques of chemical and biological warfare.
- (h) Purification of water for drinking
- (i) Plastic surgery
- (j) Cloning

#### **Answer:**

- (a) Mass vaccination is good.
- (b) Television for eradication of illiteracy and for mass communication of news and ideas is really good.
- (c) Prenatal sex determination is not bad, but people are misusing it. They must be educated to avoid its misuse in creating imbalance between the male and female population.
- (d) Computers for increase in work efficiency are good.
- (e) Putting artificial satellites into orbits around the earth is a good development.
- (f) Development of nuclear weapons is bad as they are the weapons of mass destruction.
- (g) Development of new and powerful techniques of chemical and biological warfare is really bad as these weapons are for destruction of mankind.
- (h) Purification of water for drinking is good.
- (i) Plastic surgery is good.
- (j) Cloning is also good.

### **Question 12.**

India has had a long and unbroken tradition of great scholarship – in mathematics, astronomy, linguistics, logic and ethics. Yet, in parallel with this, several superstitious and obscurantistic attitudes and practices flourished in our society and unfortunately continue even today – among many educated people too. How will you use your knowledge of science to develop strategies to counter these attitudes?

#### **Answer:**

To get rid of superstitious and obscurantistic attitudes and practices flourishing in our society, there is a dire need to educate a common man about the advancements, the scene has made. The media, such as newspapers, radio, television, etc can play a vital role for this purpose. Further, the teachers in class-rooms can prove quite effective to acquaint the young minds about these advancements.

### **Question 13.**

Though the law gives women equal status in India, many people hold unscientific views on a woman's innate nature, capacity and intelligence, and in practice give them a secondary status and role. Demolish this view using scientific arguments, and by quoting examples of great women in science and other spheres; and persuade yourself and others that, given equal opportunity, women are on par with men.

#### **Answer:**

The nature had made a little difference in the anatomy and feelings of man and woman.

**There is no difference in the capacity of the woman in:**

1. Decision making,
2. owning responsibility,
3. work and
4. intelligence.

It is biological fact that the development of human brain does not depend upon the sex but on the nutrition contents and heredity. She is endowed with fore-bearance and withstanding stress as additional qualities as compared to man. Hence she is

more suitable for administrative and public relation work. She has a persuasive power that makes her an excellent teacher. The exam results of various boards, universities and public exams indicate that girls always excel boys which is a clear scientific evidence that woman is not inferior to man in any sphere of activity like, sports, scaling of mountains as Himalaya or treatment of patients as being a doctor. We can quote examples of successful women in science and other spheres. The names of Madam Curie, Sarojini Naidu, Indira Gandhi, Mrs. Benazir Bhutto, Mrs. Bhandamaik, Mother Teresa, Margret Thatcher, Lata Mangeshkar drawn from field varying from science to management and Rani Jhansi as the warrior queen are very well known to the world who proved to be far superior than men. Hence we can say that scientifically women are on par with men.

Moreover the nutrition content of pre-natal and post-natal diet contributes a lot towards the development of human mind. If equal opportunities are given to both men and women, then the female mind will be efficient as male mind.

#### **Question 14.**

“It is more important to have beauty in the equations of physics than to have them agree with experiments”. The great British physicist P.A.M. Dirac held this view. Criticize this statement. Look out for some equations and results in this book which strike you as beautiful.

#### **Answer:**

The statement of great British Physicist P.A.M. Dirac is partially true.

**For example :**  $F = ma$ ;  $E = mc^2$  are some of the simple and beautiful equations of Physics which have universal application. However, this is not the case always. The equations involved in general theory of relativity and some of the latest works of higher Physics are neither simple nor beautiful. They are rather difficult to understand.

#### **Question 15.**

Though the statement quoted above may be disputed, most physicists do have a feeling that the great laws of physics are at once simple and beautiful. Some of the notable

physicists, besides Dirac, who have articulated this feeling, are : Einstein, Bohr, Heisenberg, Chandrasekhar and Feynman. You are urged to make special efforts to get access to the general books and writings by these and other great masters of physics.

#### **Answer:**

It is quite true that the great laws of physics are at once simple and beautiful. For instructive and entertaining general reading on science, the students are advised to read

**some of the following books :**

1. Surely You're Joking, Mr. Feynman – by R.P. Feynman.
2. One, Two, Three... Infinity – by G. Gamow
3. Physics can be Fun – by Y. Perelman.
4. The Meaning of Relativity – by A. Einstein.

**Question 16.**

Textbooks on science may give you a wrong impression that studying science is dry and all too serious and that scientists are absent- minded introverts who never laugh or grin. This image of science and scientists is patently false. Scientists, like any other group of humans, have their share of humorists, and many have led their lives with a great sense of fun and adventure, even as they seriously pursued their scientific work. Two great physicists of this genre are Gamow and Feynman. You will enjoy reading their books.

**Answer:**

It is not an exercise as such but is a statement of fact. We can add the name of other scientist who were humorists along with being Physicists. They are C.V. Raman, Homi Jahangir Bhabha, Einstein and Bohr. India have several politicians like M.M. Joshi, V.P. Singh etc. who are Physicists. Former President Dr. A.P.J. Abdul Kalam was also great nuclear scientist.