Isaac Newton (1642-1727) The Discoverer of the Law of Gravitation

The great English scientist Isaac Newton was born in the little village of Woolthorpe, not far from the old university town of Cambridge, on December 25, 1642. His father, a farmer, died before his son's birth. Little Isaac was left to the care of his mother, uncle and grandmother who sent him to school.

In his early years young Isaac shone more as one who could make things with his hands than a scholar. His neighbours watched him making various things and thought he would probably become a well-known clock maker. There was ground for thinking thus because he had already made a clock of a kind which his neighbours had never heard of before. It worked by water. Besides the water-clock, Isaac also made a sundial. His grandmother was never at a loss to know the hour; for the water-clock could tell it in the house, and the sundial outside. It is said that the sundial is still at Woolthorpe, on a wall of the house where Newton lived.

When he grew older, however, he took a considerable interest in mathematics.

Though Isaac never lost his manual skill his ability as a mathematician and a physicist was the most important in his life. According to Newton himself, his first physical experiment was carried out in 1658, when he was sixteen years old. Wishing to find out the strength of the wind during a storm, he jumped against and before the wind and by the length of his jump he could judge the strength of the wind. Thus, even in his boyish sports, he was searching out the secrets of nature and could find out difficult things in simple ways. His brain was always busy observing different phenomena of nature.

Not far from his grandmother's home there was a windmill. When the windmill was not working he examined the mechanism and when the windmill worked he watched the process of its work. Then he made a model of the windmill; every part of the mill and its machinery was complete.

If Isaac was left to himself, he was either making something or studying some book. At night he looked up at the stars, and wondered if they were worlds like our own, and how great their distance from the earth was.

There were a lot of questions in his mind but nobody was able to answer them.

When Isaac was fourteen years old, his mother took her son from school to help her on the farm at Woolthorpe, where she lived with three other children – Isaac's brother and two sisters. For more than two years he worked on the farm and then his mother sent him back again to school to prepare for the University.

On June 5, 1661, Newton entered the University of Cambridge where he studied mathematics. Soon he became famous having made a number of important contributions to mathematics by the time he was twenty-one.

When Newton was twenty-two years old he began studying the theory of gravitation. In 1665, while on a visit in his native village, he saw an apple fall from a tree and began wondering what force made the apple fall. Probably this was influenced by his knowledge of Galileo's experiment from the Tower of Pisa.

The Problem of Gravitation

We know that the moon makes a circle round the earth in about every twenty-eight days. We know also that our earth and other planets move around the sun. Does it not seem probable that the earth pulls the moon, and it moves in its orbit under the influence of the earth's gravitation? Perhaps also the sun pulls the earth and the other planets.

It was over such possibilities that young Isaac Newton was thinking in the solitude of his Lincolnshire home when the Great Plague raged in London and he, along with other students, was sent home from Cambridge because of this plague. In that quiet period of almost two years he finished considering his discoveries which had perhaps the most far-reaching effect in the whole history of science: the method of fluxions, decomposition of light and the law of gravitation.

As a young man at Cambridge Newton had read with great interest the writings of Galileo, he knew the geometry of Descartes, and he had already partly worked out the methods of calculus, which he called the method of fluxions. So when he began to think «of gravity extending to the orb of the moon», as he wrote, he immediately put this idea to the test of calculation.

When Newton first began his calculations the available information of the earth's radius and of the moon's distance was not accurate. The relative distance between the various planets was not accurately known at the time. Newton did not know whether he could treat the sun and the planets as though they were points, concentrated at their respective centres through which he could assume the forces acted so he put his calculations aside and let the problem wait.

For some years he studied light, in which subject alone his work was enough to place him in the first ranks among men of science.

Newton performed many experiments with light and found that white light was made up of rays of different colours. He invented the reflecting telescope, that was very small in diameter, but magnified objects to forty diameters. Newton developed a mathematical method which is now known as the Binomial Theorem and also differential and integral calculus.

In 1669 he was appointed professor and began lectures on mathematics and optics at Cambridge.

Newton's Theory of Gravitation

Some years after Newton had begun to work on the problem of gravitation a French observer made a new estimate of the earth's radius, and reported his results at a meeting of the Royal Society. Newton then reviewed his old notes and examined the information he had. He found that now he was nearer to the solution of the problem than before, but he did not publish his results, he was still not satisfied, because his theory was not completely worked out.

However, the time had come to publish his results on gravitation because the problem was being discussed on all sides. An important work on centrifugal force by a Dutch scientist Christian Huygens appeared in 1673. The mathematical difficulties seemed insurmountable, so Huygens, together with some Fellows of the Royal Society approached Newton on the subject. He was asked what path a body would take if it were attracted by a mass with a force acting inversely as the square of the distance. And Newton's immediate answer was, «An ellipse».

Newton gathered together all his earlier calculations, and succeeded in completing his whole theory. First he examined the general problem of the attraction of one mass by another. He showed that a massive sphere attracts another as if the whole mass were concentrated at the centre. This was a result of great importance. It enabled Newton to treat the problems of the sun, moon and earth like problems of geometry, for the masses of these bodies could be treated as if concentrated at points. Thus he at last justified the method of treatment which he had first adopted for the problem of the earth and moon. The proof of his inverse square law was now complete. He had demonstrated that the gravitational pull of the earth extends as far as the moon and keeps it in its orbit. He demonstrated that this pull is in accordance with the same law as that by which a stone falls to the ground, namely gravity.

Newton then showed that the inverse square law represents not only Kepler's third law, but his first two laws as well. Thus he not only combined

the three results of Kepler, but he extended his own theory of gravitation to the movements of the planets round the sun. The whole machinery of the solar system was thus brought under the sway of one law, which states that every particle attracts every other particle with a force which changes inversely as the square of the distance between them. This statement is part of Newton's law of gravitation, which, together with all his other theories, was given to the world in his great work *Elements of Natural Philosophy* published in 1687.

It is interesting to note that Newton did not want to publish his book. He locked it in his desk and decided to keep it there forever.

However, other scientists began to take interest in the subject of gravitation. Astronomers, physicists and others talked about it at conferences in London. Wren, the famous architect, offered a prize to any scientist who could prove why the path of a planet must be an ellipse. But nobody could do it. In August of 1684 Halley, the astronomer, visited Newton at Cambridge and asked him if he could solve the problem. Newton said he had already got the answer, and promised to send his manuscript some time later. Halley received the manuscript in the autumn of the same year but Newton's great work, *Elements of Natural Philosophy*, was published only in the middle of 1687. With this book, a new period in the development of science began.

Newton's law of inverse squares thus joined in one simple mathematical statement the behaviour of the planets as well as of bodies on this earth. It was the first synthesis of physical knowledge. As such his contribution to science is unique.

Isaac Newton gained great fame. But he cared little for it. All that he had learned and discovered only made him feel how much more there was that he did not know.

It is now easy for us to understand how important Newton's work was. The publication of *Elements of Natural Philosophy* was compared to the sunrise. His laws (in their specific fields) will be used till humanity and its science and technology exist. That is why Newton's work is immortal, it outlived his time and it will always live. But Newton himself was always modest. Once he said that he had been only as a child playing on the seashore, while the immense ocean of truth extended itself unexplored before him.

Newton devoted all his time to science. Working at difficult questions he forgot everything else. On such days he kept to his room, and did not allow anyone to disturb him. Sitting half dressed on his bed he remained there in thought all day long eating only when food was brought to him and not noticing what he was eating.

One morning he was working very hard, and did not leave his room to go and have breakfast with the family. The housekeeper, however, sent one of the maids into his study with an egg and saucepan of water. The maid

had been told to boil the egg and stay while he ate it, but as he wished to be alone, Newton sent her away, saying that he would cook it himself. The maid left it near his watch on the table, and, telling him to let it boil for three minutes, left the room. She returned soon after and found Newton standing deep in thought, the egg in his hand, while his watch was boiling in the saucepan.

Isaac Newton's temper was so mild, nothing could disturb it, as can be seen from the following incident. He had a little dog which was called Diamond. One evening Newton went out of his study leaving Diamond there and when he returned a few minutes later, he saw that a lighted candle had been pushed over on its side among some papers and that the nearly finished work of many years was in flames. As Newton was already an old man, the loss was irreparable, but he did not punish the dog, he only exclaimed, «O Diamond, Diamond, you do not know the mischief that you have done».

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Isaac Newton died in 1727 at the age of 85. He was buried with honours, as a national hero. It was the first time that national honours of this kind had been accorded in England to a man of science.

Questions

1. Where was Newton born?
2. What abilities did Isaac display?
3. How did Isaac make a model of the windmill?
4. What did Newton study at Cambridge University?
5. What did Newton find out with light?
6. What is Newton's theory of gravitation?
7. What facts prove that Newton was absent-minded?
8. What are famous works of Newton?
9. What helped I. Newton to find out the theory of gravitation?
10. In what way did Newton extend the theory of gravitation?
11. Find sentences where Past Perfect is used and explain the usage.
12. Explain in your own way how you understand the theory of gravitation.