WHAT EINSTEIN DID

Albert Einstein discovered one of the most important pieces of new knowledge of the twentieth century. It is a simple formula, perhaps the only formula of advanced physics that most people know: $E=mc^2$. To understand what it means we have to go back a few steps.

Einstein was born in the cathedral city of Ulm, Germany, in 1879. By the age of twelve he had determined to solve the riddle of the "huge world." Unfortunately, his grades were not good, and he loft school at fifteen. He managed to begin studying again arid eventually graduated from the university with a degree in mathematics in 1900. Unknown to the world, lie began work as a patent examiner. Then, in four extraordinary scientific papers published in 1905, he went farther toward solving the riddle of the world than any man before him.

Any one of those papers would have made the reputation of another physicist. The first provided an explanation of Brownian motion, a previously inexplicable phenomenon involving the motion of small particles suspended in a liquid. The second paper resolved the three-centuries-old dispute about the composition of light. Einstein's paper proposed that light is composed of photons that sometimes exhibit wavelike characteristics and at other times act dike particles. This cutting of the Gordian knot was not simplistic. Backed by solid mathematical reasoning, it was immediately seen as the solution of this great problem. The proposal also explained the puzzling photoelectric effect (the liberation of electrons from matter by light).

Paper number three was even more revolutionary, for it proposed what came to be called the Special Theory of Relativity. Einstein said, if we can assume that the speed of light is always the same and that the laws of nature are constant, then both time and motion are relative to the observer.

Einstein provided homely examples of his idea. In an enclosed elevator, a rider is not aware of up or down motion, except, perhaps, in his stomach if the elevator goes too fast. Passengers on two speeding trains are not aware of their overall speed but only of their relative speed, as one, going just a little faster than the other, passes slowly out of sight. Physicists did not need such examples to recognize the elegance and economy of the theory.

The theory explained many things. So did its expansion, in a paper of 1916, into what Einstein called the General Theory of Relativity. In the 1916 paper Einstein posited that gravitation is not a force, as Newton had held, but a curved field in a space-time continuum that is created by the presence of mass. The idea could be tested, he said, by measuring the deflection of starlight as it passed close to the sun during a total eclipse.

Einstein predicted twice the amount of deflection that Newton's laws predicted.

On May 29, 1919, the experiment that Einstein had called for was made by a vessel sent by the British Royal Society to the Gulf of Guinea. The announcement that Einstein had been precisely correct in his prediction came in November and immediately made him world famous. He won the Nobel Prize for Physics in 1921, but he was already file most famous scientist in the world, so much so that he was treated everywhere almost as a kind of circus freak. This displeased him, as it gut in the way of his work.

One other paper had been published in 1905. In some ways it was the most important of all. An extension of the previous paper on relativity, it asked the question whether the inertia of a body depends on its energy content, and answered in the affirmative. However inertia had been held to be dependent on mass alone. Henceforth the world would have to accept the equivalence of mass and energy.

The equivalence is expressed in the famous formula, which says that E, the energy of a quantity of matter with mass in, is equal to the product of the mass and the square of the (constant) velocity of light, c. That velocity, which is also the speed of propagation of electromagnetic waves in free space, is very great: 300,000 kilometers per second. Squared, the number is enormous. In a tiny unit of matter, therefore, is imbedded a gigantic amount of energy, enough, as we learned later, to kill two hundred thousand citizens of Hiroshima with the explosion of a single bomb.

Einstein was a pacifist. He hated war and, after 1918, feared that war would soon erupt again before the world could enjoy a secure and lasting peace. He did what he could to support the Ideas of world government that circulated in the interbellum era. But Einstein the peacemaker was not its influential as Einstein the physicist.

When Adolf Hitler took over Germany in 1933, Einstein renounced German citizenship and filed to the United State. There he continued his work on the General Theory while he sought ways for the angry world to agree to begin to agree. In 1939 when word reached him that two German physicists had split the uranium atom, with a slight loss of total mass that was converted into energy, he realized that war in itself was not the only danger. And, urged by many colleagues, he sat down and wrote a letter to President Franklin D. Roosevelt (1882-1945).

No one else could have written it with such authority. The letter was simple. It desorbed the German experiments and noted that they had been confirmed in the United States. He observed that a European war seemed to be imminent. In the circumstances the possession by Nazi Germany of a weapon based on the fission of the uranium atom could be overwhelmingly dangerous to the rest of the world. He urged upon the president "watchfulness and if necessary, quick action."

The president wrote polite reply. But the warning had not fallen on deaf ears. No one tale Einstein, the pacifist, but a crash program, the greatest and most expensive scientific project up to that time, was begun. Called the Manhattan Project, it was initiated with a six thousand dollar research allocation in February 1940. The total expense would finally grow to more than two billion dollars, the equivalent of many billions of dollars today. When America entered the war, after the Japanese attack on Pearl Harbor at the end of 1941, the pace of the research became feverish. Until 1943, the work was mainly theoretical, but by early 1945 enough progress had been made to begin plans for the test exposing of a bomb. This explosion occurred at Alamogordo Air Base south of Albuquerque, New Mexico, on July 16, 1945. The text proved completely successful, the bomb generating an explosive power equivalent to some twenty thousand tons of TNT. The bomb that would devastate Hiroshima was dropped three weeks later, on August 6.

Einstein was both happy and brokenhearted. The bomb, in the hands of Hitler, would have meant the end of freedom in the world, and the final obliteration of the Jewish people. He struggled to make the newly founded United Nations a better instrument for peace than it was, than it could be, for he feared that the bomb would be used again, and for worse reasons. He continued to work on his unified field theory, which would show how all natural laws could be expressed in a single theoretical construct, perhaps a single equation. But he had left the rest of the scientific community behind, and they increasingly relegated him t isolation. When he died in 1955, he was the only man in the world who believed that he was right about the overall structure of the universe, he who had led mankind to understand more of that structure of the universe, he who had led mankind to understand more of that structure than any scientist since Newton.

Comprehension:

1. What did Albert Einstein discover?
2. What was he determined to do at the age of twelve?
4. Why did he leave school at fifteen?

5. In which subject did he graduate?
6. What outstanding achievement did he have in 1905?
7. What was his first scientific paper about?
8. What did his second paper solve?
9. By what was his theory based?
10. What do you mean by 'photoelectric effect?
11. Why was his paper number three even more revolutionary?
12. What was the simple example of his idea about theory of Relativity?
13. How did Eihnstein defiine gravitation in his 1916 paper?
14. In what way did Einstein's idea about gravitation differ from that of Newtion?
15. How could this idea be tested according to Einstein?
16. What was Einstein world famous?
17. When was Einstein awarded Nobel Prize for physics?
18. What displeased Einstein? Why?
19. Why was the paper published in 1905 the most important of all?
20. What is the meaning of $E= mc^2$?
21. Why was Einstein considered to be pacifist?
22. When did Einstein give up his German citizenship? Why?
23. When did Einstein realize that war was not the only danger?
24. What did he write in his letter to president FranklinD. Roosevelt?
25. When did America enter the second world war?
26. When was Hiroshima devastated?
27. Why was Einstein both happy and brokentearted?
28. Why did Einstein feel fear?
29. What would Einstein's unified field theory show?
30. What did Einstein do?

Long- Answer questions:

1. Describe the contribution of Einstein to the modern scientific world?
2. Describe Einstein's foyur scientific papers in as much detail as you can.

Discussion question:

1. "Einstein was a pacifist." Do you agree with this? How?
2. "Einstein was the greatest genius of the 2oth century." Explain it.

Composition:

1. With the help of reference books and internet, describe in your own words, Einstein's theory of Relativity?
2. Write a letter to your small brother describing the childhood of Einstein his study and achievement.