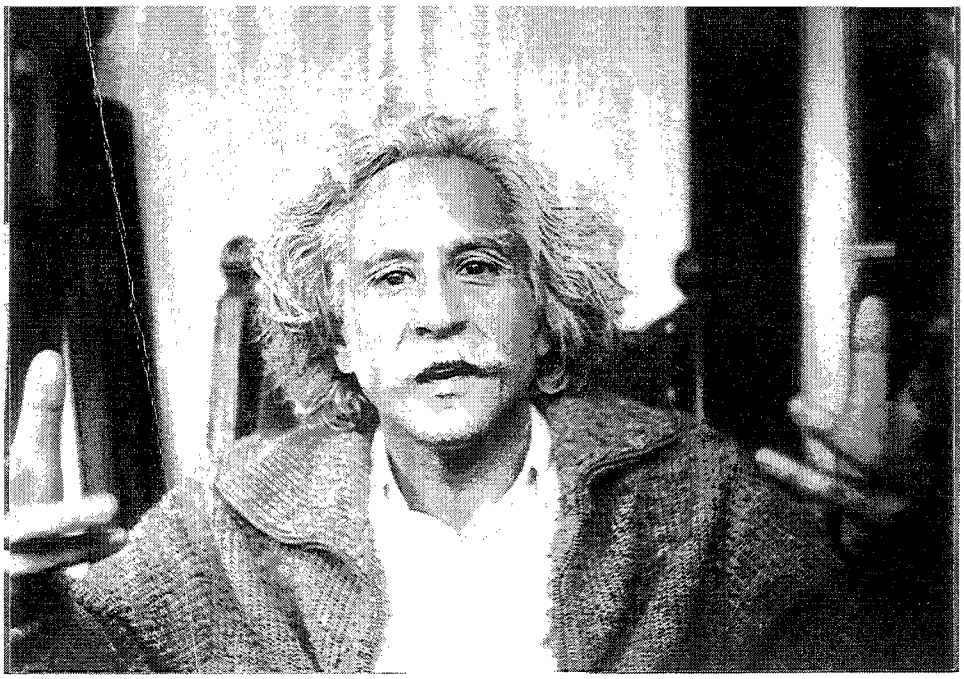
Pre-Performance Material For

Einstein Alive



Presented by
Marc Spiegel

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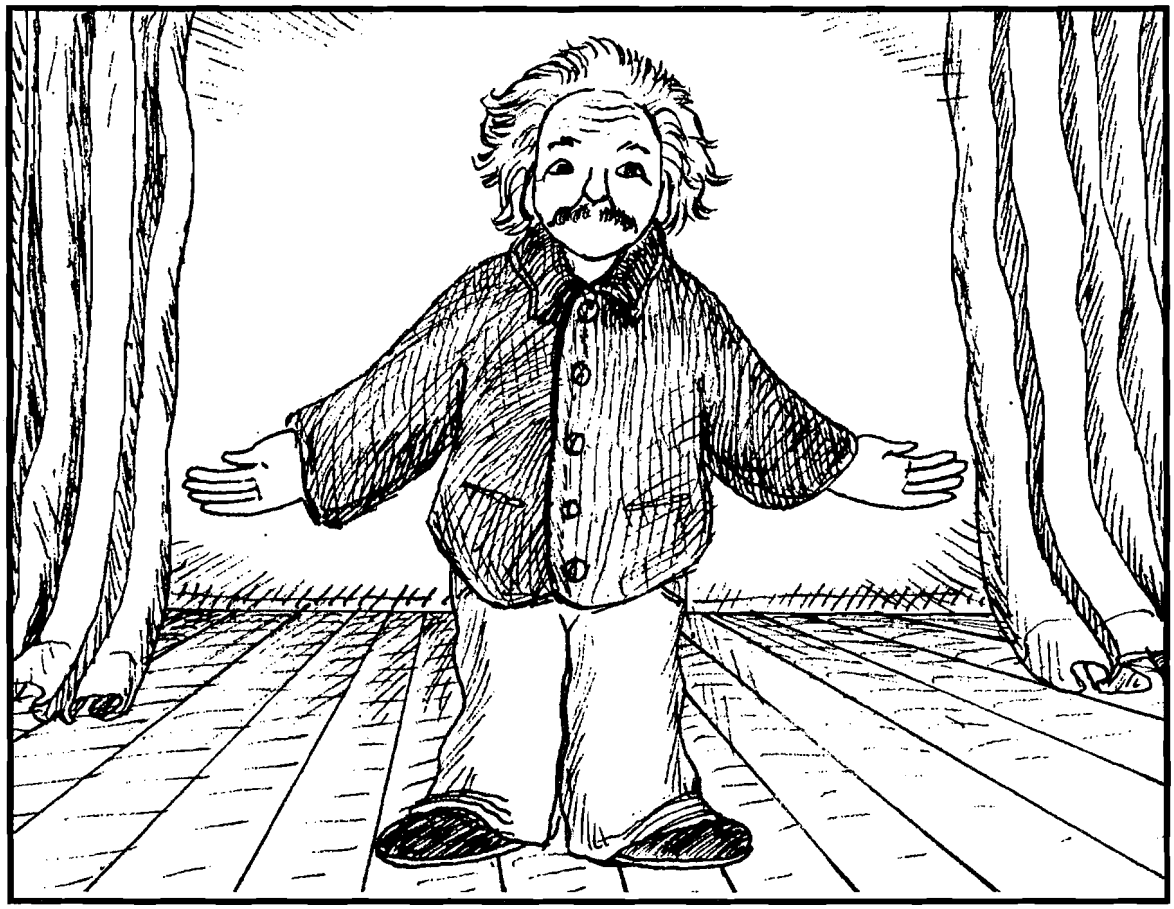
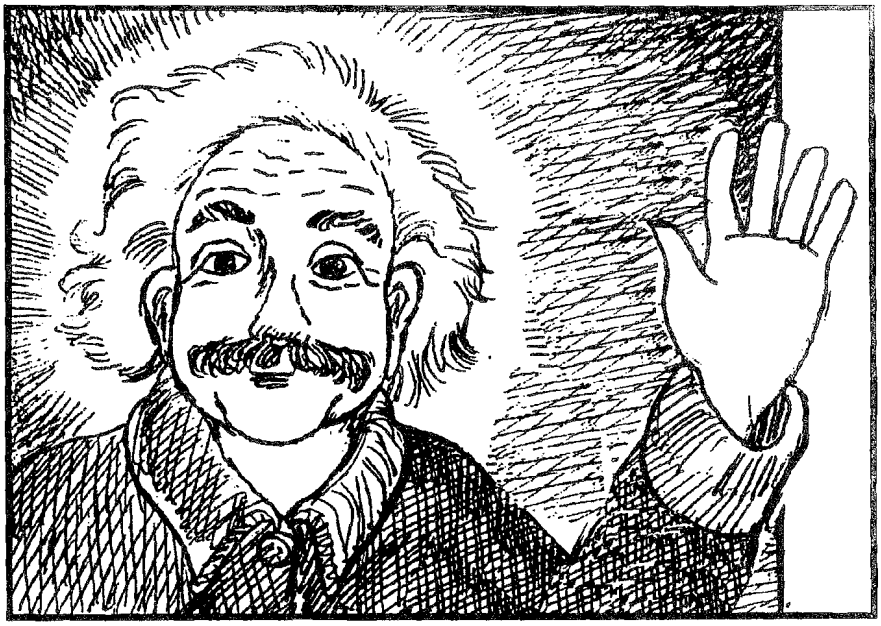
Einstein Alive



Hello, I am Albert Einstein and I am here with some names, words and ideas to help you prepare for the program coming to your school called "Einstein Alive"

If you feel that this material is too extensive or complex, do not worry. It is not necessary to understand it completely or to memorize it in any way. I, myself, had a very poor memory. Just to have once discussed the names and ideas presented here before the program will be helpful. If you are able to do more, it will be more helpful.

The teacher may decide to keep this booklet for his or herself and present the material to the students in her or his own way. It is perfectly fine with me, however, if it is xeroxed and each student given a copy.

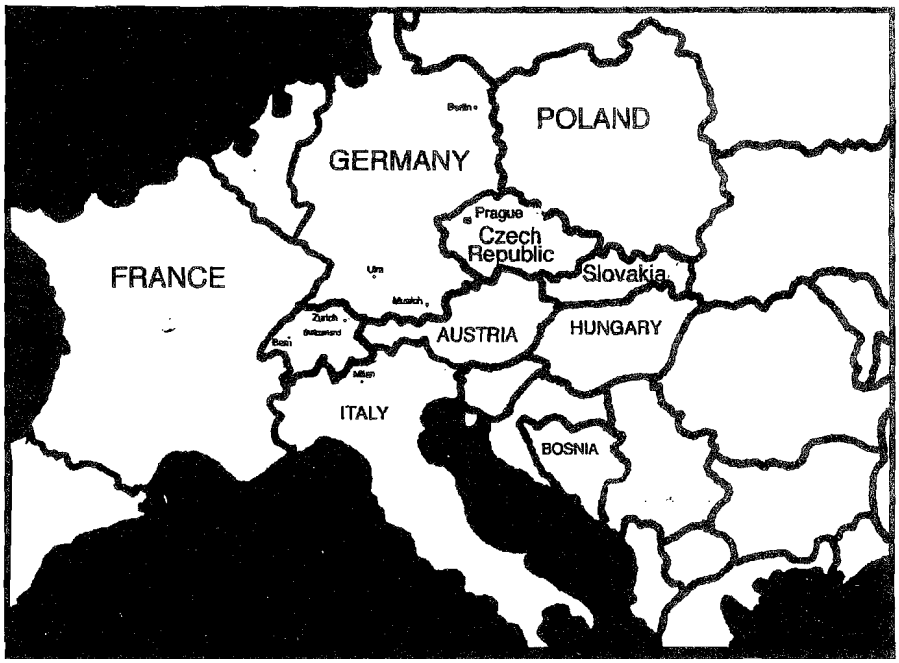


On these pages I am a cartoon. In the program I will be played by an actor. Although I was a real person, today I must be represented by an illustration or an actor because I died about 50 years ago. Even so, whenever I am represented in any way, part of me comes alive once more, sometimes in ways which surprise even me.

I was born on March 14, 1879 in Europe in the small city of Ulm which had just recently become part of the newly created state of Germany.

During my life I considered myself a traveling gypsy. I lived in many different places. I have been a citizen of 4 nations.

Europe 1995



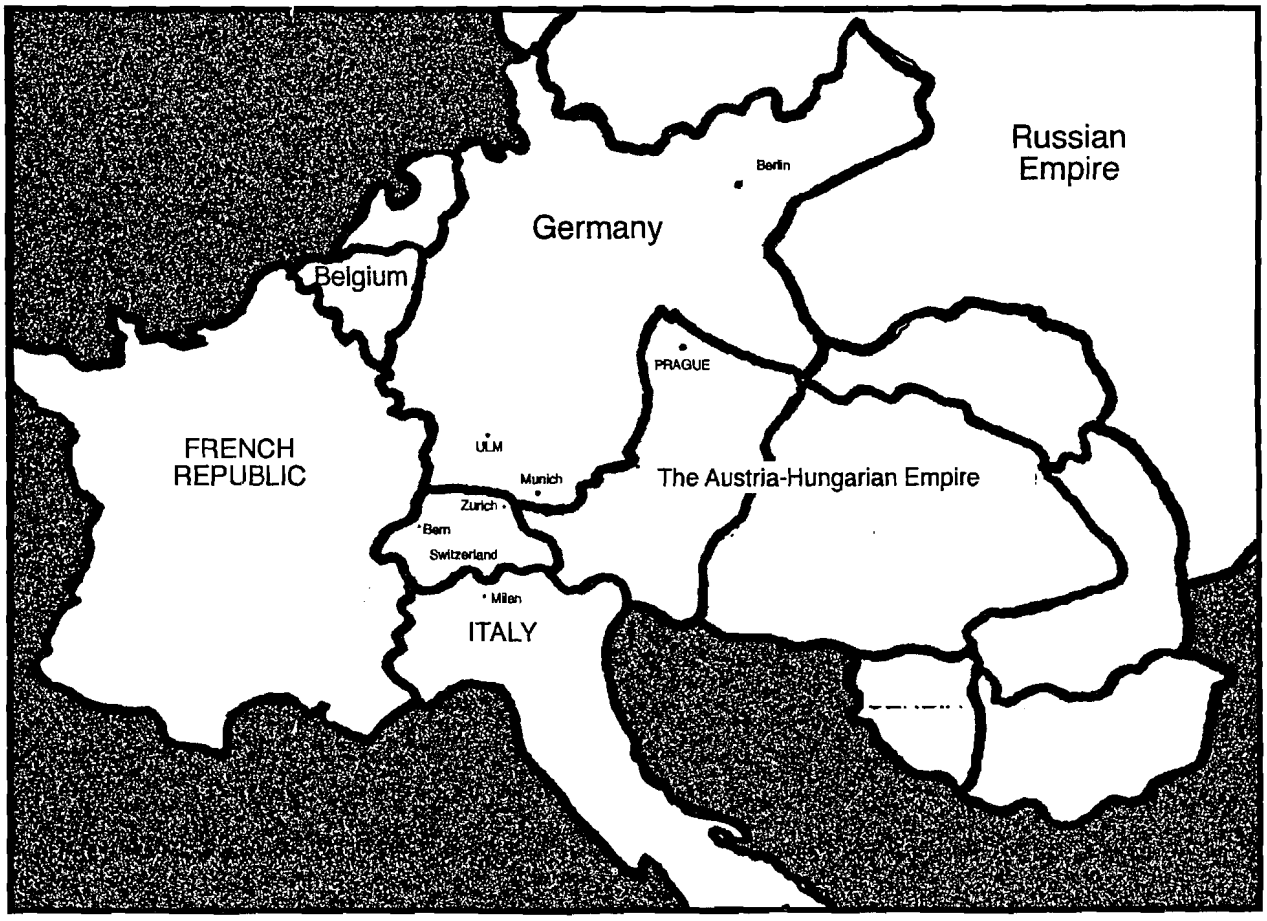
When I was one year old my family moved from Ulm to Munich which is also in Germany. When I was 15 my family moved again to Milan, Italy leaving me in Munich to complete my high school education. I did not think this was a very good idea and the next year which was 1895 I left school under somewhat complicated circumstances which I will explain when I see you in the upcoming program. After living a year in Italy I went back to school in the country of Switzerland. I became a Swiss citizen in 1901.

The major cities I have lived in include Bern and Zurich which are both in Switzerland, the city of Prague which is today in the Czech Republic, but was then part of the Austro-Hungarian Empire. My last home in Europe was in the capital of Germany, Berlin.

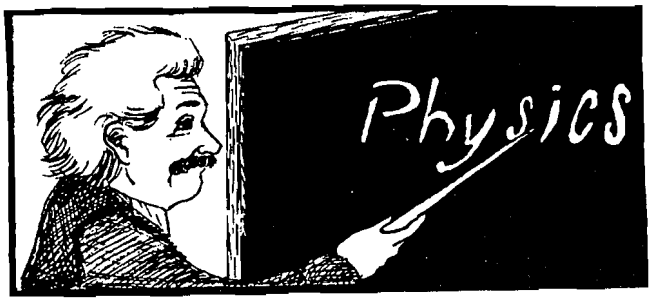
With the coming to power of Hitler and the Nazis in Germany, since I was Jewish it was no longer safe for me to live in Berlin. In 1933 I moved to the United States where I lived the last 22 years of my life in Princeton, New Jersey. I became an American citizen in 1940.

I died in Princeton, New Jersey on April 18, 1955.

Europe 1900



Wherever I lived and whatever I might have been doing, I was first and foremost a theoretical physicist. This means that I was a scientist who studied the science of Physics and who developed theories about it.



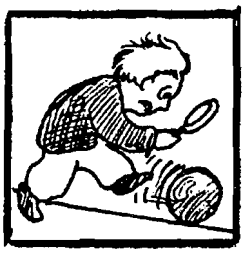
Physics was the very first science. It is the search for the fundamental laws of nature.

It is the study of matter and energy and the relations between them.

The physicist asks very basic questions such as:

"What causes heat?"

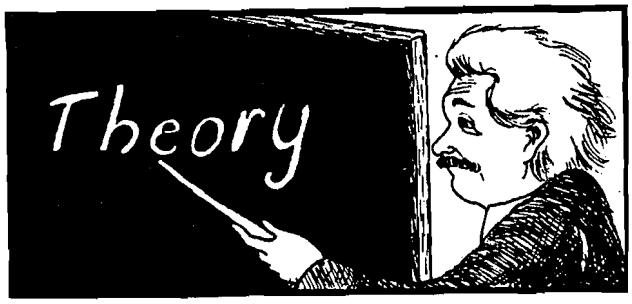
"How do things move?"



"What is light?"

"Why do things fall?"

A theory is a way of explaining things which we do not yet understand.



We look at what we do know, the "facts" which we can see and measure in some way. Then we use our imagination to try to describe what we do not know.

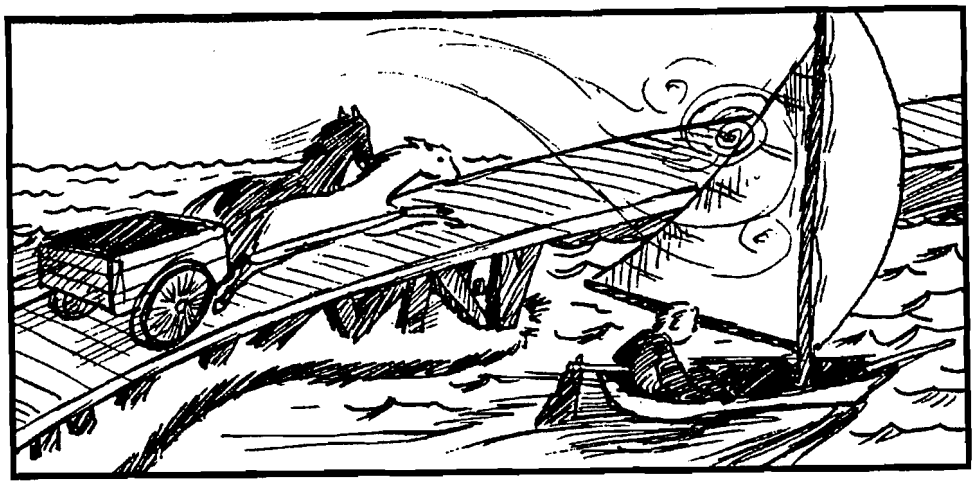
As we learn more, new "facts" may prove a theory wrong. If a theory survives for a long enough time or seems to explain everything we know, it is sometimes called a Law or a Principle such as "the law of gravity."

Even a law or a principle can proven wrong, however, as new knowledge is gained.

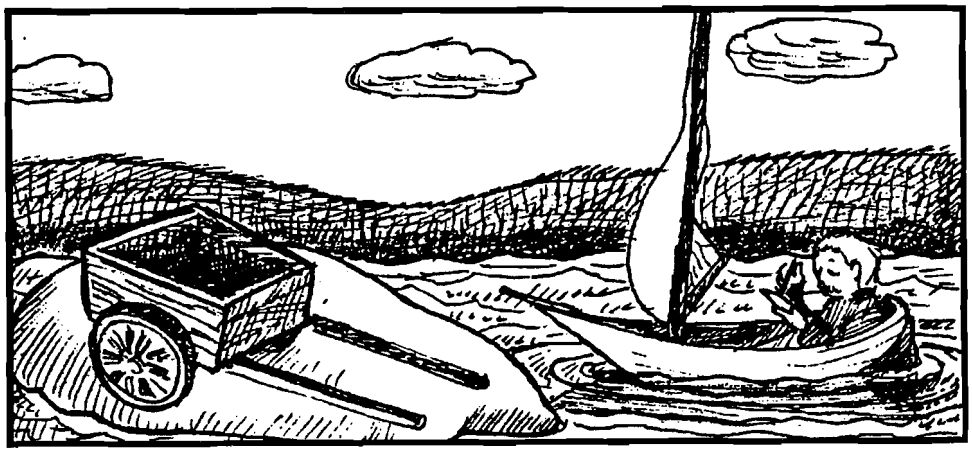
AN ANCIENT THEORY ABOUT MOTION :

2300 years ago Aristotle, a famous scientist in ancient Greece felt the Earth was standing still. Yet he saw the sun, moon, planets and stars moving across the sky .

Aristotle imagined a theory which said that the "natural" state of heavenly bodies was to move. The "natural" state of the Earth and all objects on it, however, was to be "at rest" unless something forced them to move.



A cart moved if horses pulled it. A sailboat moved if the wind pushed it.

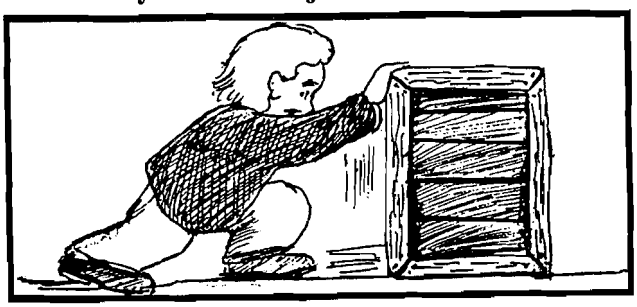


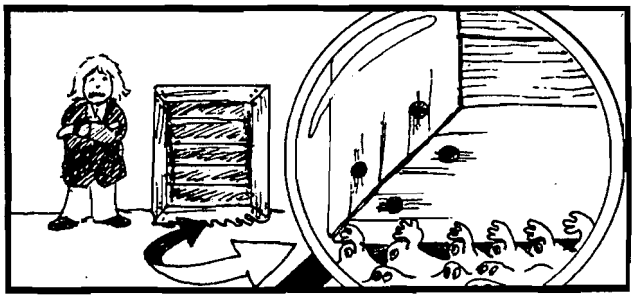
When the force of the horses or wind stopped the cart or boat naturally stopped as well and once again was "at rest."

ARISTOTLE'S THEORY WAS WRONG! Yet it was accepted for over 1600 years.

By the 16th century other scientists began to observe the heavens more carefully. In Italy GALILEO GALILEI began to more carefully observe objects in motion.

Galileo showed that while a force such as a "push" or a "pull" would make an object move,





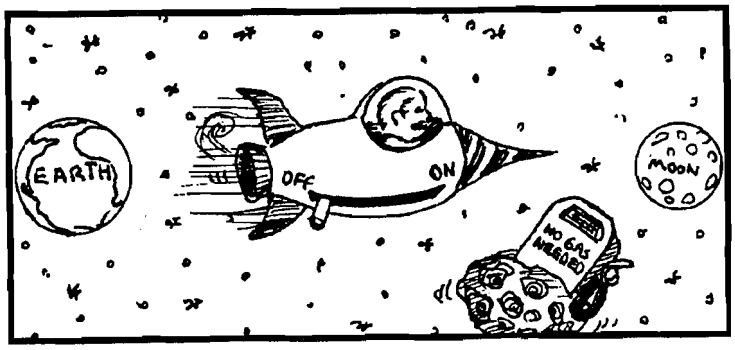
when the pushing or pulling stopped, what really stopped the object was another force called friction.

Friction is the "push" of nicks and bumps, often invisible to normal vision, that are on even what appear to be very smooth surfaces.

Twenty-four years after Galileo died, ISAAC NEWTON, then only 23 years old, replaced Aristotle's theory of motion by turning Galileo's ideas into what Newton called his 1st Law of Motion. This law basically said:

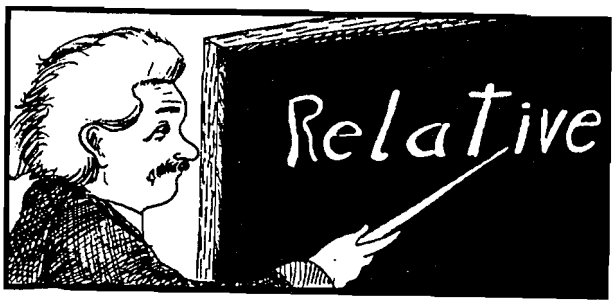
IF AN OBJECT IS AT REST IT WILL STAY AT REST OR, IF IT IS MOVING IT WILL CONTINUE TO MOVE IN A STRAIGHT LINE AT AN UNCHANGING SPEED UNLESS IT IS FORCED TO CHANGE WHAT IT IS DOING.

Because Newton's 1st Law of Motion is true, it is possible to travel to the moon even though there are no gas stations along the way.



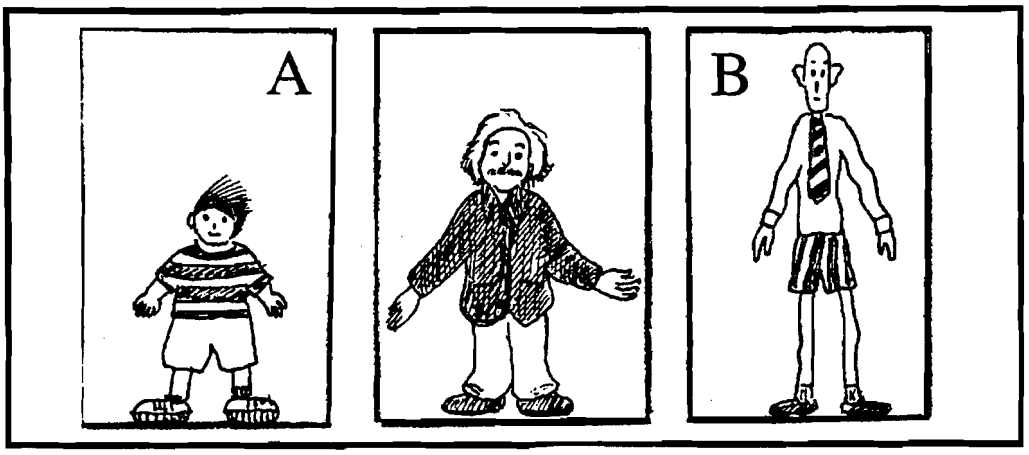
There is little friction in outer space. Once the rocket has blasted free of Earth's gravity, it can shut off its engine and the rocket will travel at whatever speed it is then going in a straight line until it reaches the gravitational pull of the moon. The astronauts only need to fire their engine if they wish to change the rocket's speed or direction.

I want to tell you two more things about motion,
but first you must understand the word RELATIVE.



I am not talking about Uncle George.
The word relative means: "in relation to, depending upon, in comparison with"

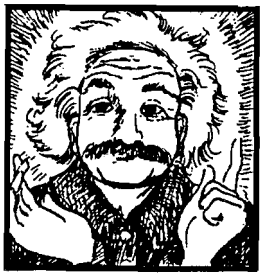
I am tall relative to person A but I am short relative to person B.



The meaning of the word relative is the opposite of the word absolute.
Absolute means: free from restriction, always true, independent of everything else."

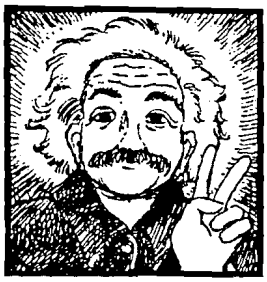
TALLNESS IS RELATIVE.
Tallness depends upon what it is being compared to. It is not absolute.

Now I can tell you those two things about motion.

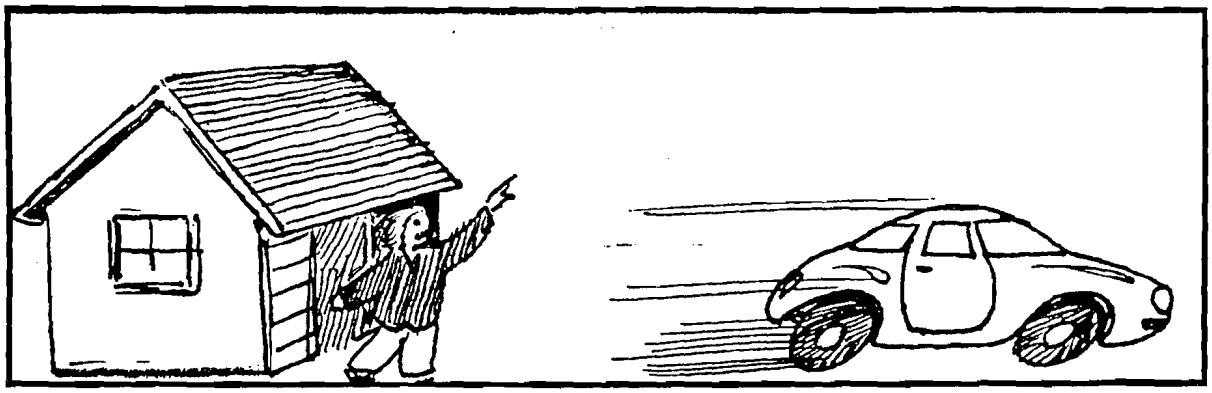


#1) MOTION IS RELATIVE

When an object moves, it always moves relative or
in relation to something. You know my boat is moving
because it is changing position relative to the house.

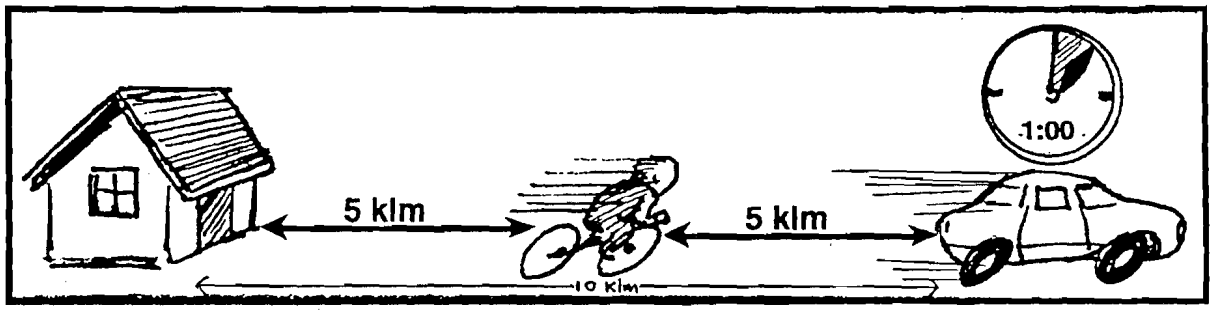


#2 MOTION HAS SPEED & THE SPEED OF MOTION IS ALSO RELATIVE.



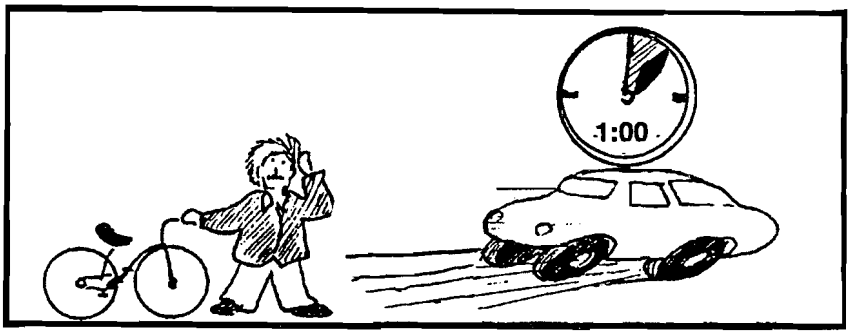
I am standing in front of my house waving goodbye as my friends drive away at a certain speed. Let us say 10 kilometers an hour. In other words after one hour the car will have moved 10 kilometers away from both me and my house.

But what if instead of waving goodbye I jump on my bicycle and follow them at a speed of 5 kilometers an hour.

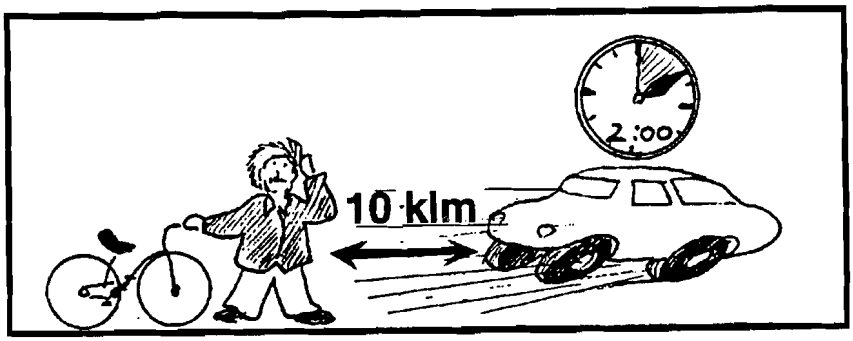


After one hour the car will still have moved 10 kilometers away from the house but I will have moved 5 kilometers away from the house so the car will have moved only 5 kilometers away from me. Relative to me the car's speed will only be 5 kilometers an hour. Relative to the house, of course, the car's speed will still be 10 kilometers an hour.

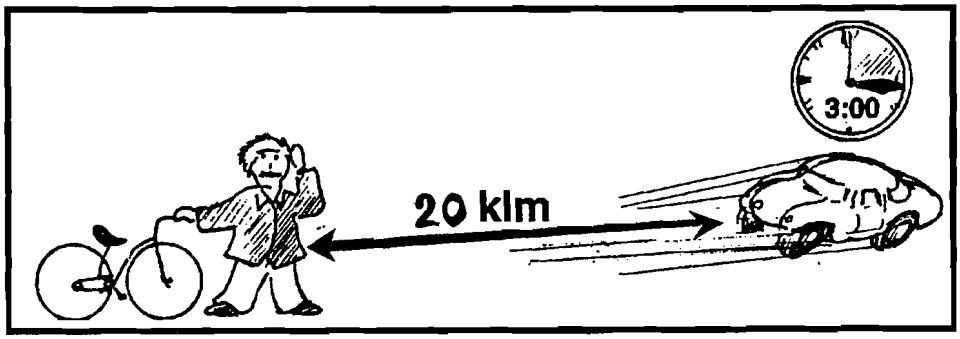
But: WHAT IS "SPEED"?



Let us say that I am off my bicycle and standing still. The car is again traveling at 10 kilometers an hour relative to me.



After one hour the car will be 10 kilometers away from me.



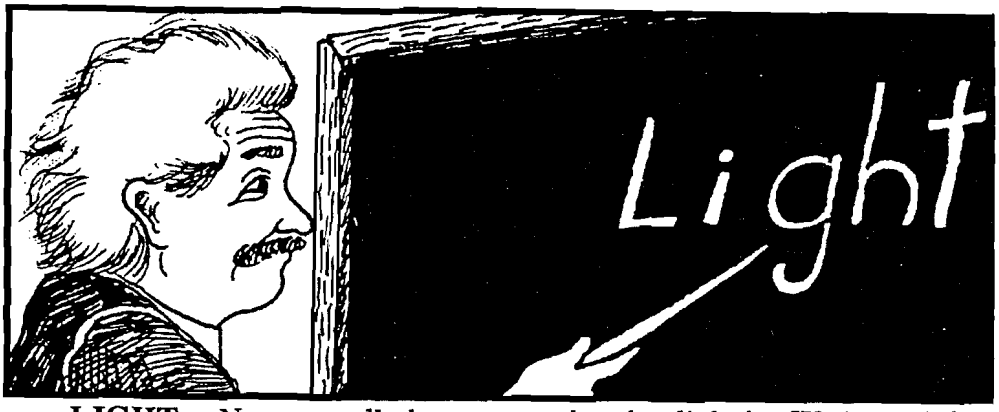
After two hours the car will be 20 kilometers away from me.

Suppose we knew that the car always traveled at the same speed and after two hours it was 20 kilometers away from me. To find out how fast it was moving each hour we have only to divide the distance traveled [20 kilometers] by the time traveled [2 hours]:

$$\frac{\text{20 kilometers}}{\text{2 hours}} = \text{10 kilometers per hour}$$

What we call "speed" is the distance traveled divided by the time spent traveling.

As long as we are talking about speed, the last thing I must mention is: "LIGHT"!

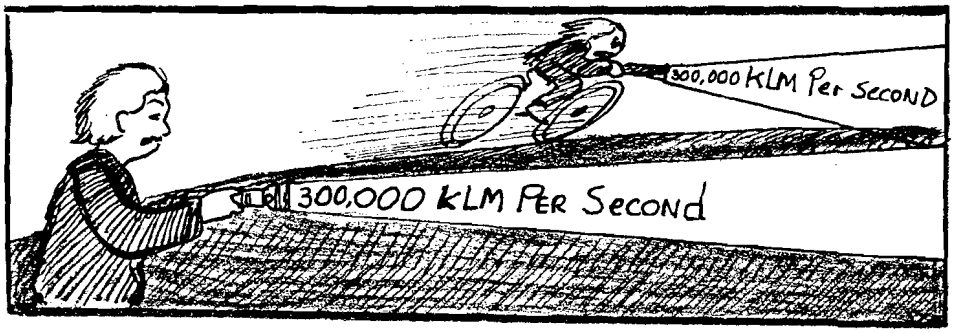


LIGHT. No one really knows exactly what light is. We know it is a form of what we call "electromagnetic energy". We understand light better today than when Galileo and Newton lived largely because we have a greater ability to measure it and observe how it acts.

The most important thing to know about light is that:

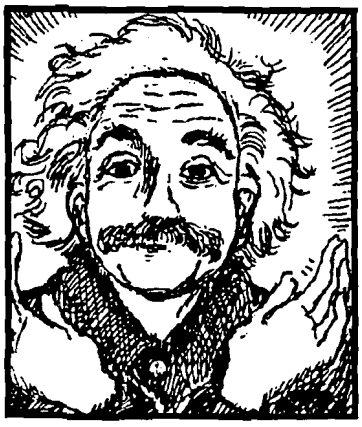
THE SPEED OF LIGHT IS CONSTANT.

It is **absolute**. It is not **relative**. The speed of light is independent of everything else. Light travels at about 300,000 kilometers per second.



Light travels away from me at 300,000 kilometers each second whether I am standing still or peddling my bicycle as fast as the wind.

Galileo and Newton had no way of measuring this speed. They laid out the foundations and the laws of physics without knowing this important fact. Because I studied physics at a time when this fact was known, I was able to change the laws of Newton as he had changed those of Aristotle.



Please do not worry if you do not completely understand everything in this booklet.

Just being familiar with the names and words will be very helpful. I look forward to seeing you when I present my program **"Einstein Alive"** at your school.