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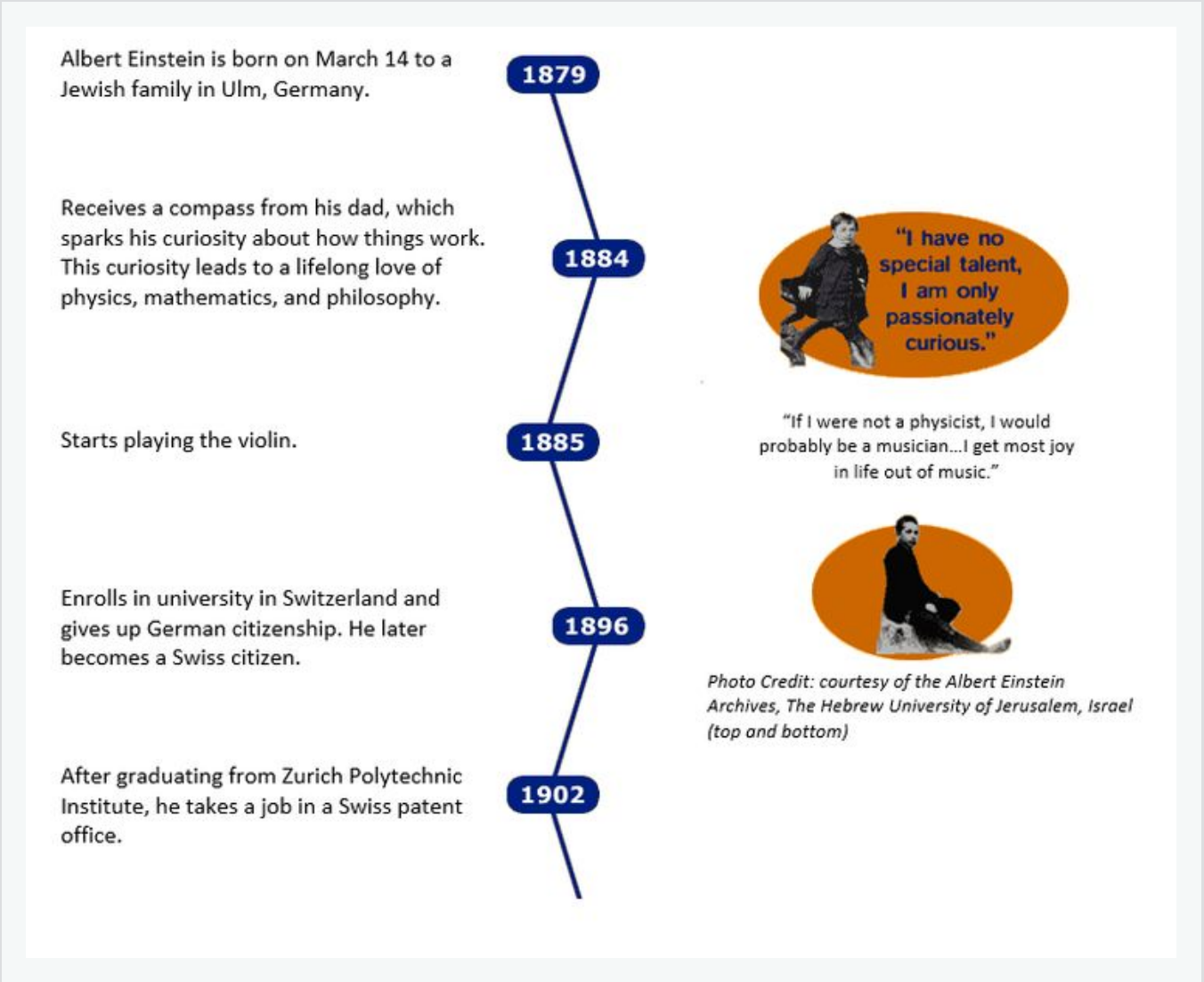
Einstein in Time

This text is provided courtesy of OLogy, the American Museum of Natural History's website for kids.

Albert Einstein has been called one of the freest people who ever lived. He didn't let anything hold back his imagination, and it powered him to completely new places. As a great humanitarian, Einstein supported causes that helped people around the globe. Take a trip through his incredible life and see for yourself!



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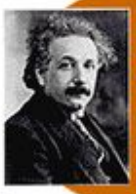
1905
Publishes papers that deal with his Special Theory of Relativity, photoelectric effect and the original version of the equation $E=mc^2$. This has been called his "year of miracles."

1919
Becomes a worldwide celebrity when Sir Arthur Eddington confirms his 1915 General Theory of Relativity. Begins to use his celebrity to champion causes he believes in, including the formation of a Jewish state.



"The bond that has united the Jews for thousands of years and that unites them today is, above all, the democratic ideal of social justice, coupled with the idea of mutual aid and tolerance among people."

Photo Credit: courtesy of the Albert Einstein Archives, The Hebrew University of Jerusalem, Israel

1921
Wins the Nobel Prize in Physics.

"One should not pursue goals that are easily achieved. One must develop an instinct for what one can just barely achieve through one's greatest efforts."

1923
While in Jerusalem, he delivers the first scientific lecture at The Hebrew University.

1925
Signs a document with Gandhi against forcing men into military service.

1932
Spends several months teaching at CalTech in Pasadena, California, where his fame leads to contact with movie stars and other celebrities.

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1933

Gives up his job at a school in Germany as the Nazi party comes to power. Joins the Institute for Advanced Study at Princeton University in New Jersey.

"I did not wish to live in a country where the individual does not enjoy equality before the law and freedom to say and teach what he likes."

Photo Credit: courtesy of the Albert Einstein Archives, The Hebrew University of Jerusalem, Israel

1939

Writes to President Franklin D. Roosevelt urging the U.S. to develop atomic energy research. He is concerned that Nazi Germany's research will soon allow it to build an atomic bomb. Later, he regrets sending the letter.

"I made one mistake in my life — when I signed that letter to President Roosevelt advocating that the bomb should be built."

1940

Becomes a U.S. citizen.

"America is today the hope of all honorable men who respect the rights of their fellow men and who believe in the principles of freedom..."

Photo Credit: courtesy of Hulton Archive/Getty

1952

Turns down an offer from the State of Israel, which is 4 years old, to be its president.

1953

Speaks out against the mistreatment of those unjustly accused of being communists during the era of McCarthyism.

"In the last analysis, everybody is a human being..."

1955

Dies on April 18 at Princeton Hospital.

2000

Time magazine names Einstein "Person of the Century."

Photo Credit: Time Magazine Cover

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Everyday Einstein: Humanitarian

Einstein is now a household word that means "genius." During his life, Einstein used his fame to draw attention to things he believed in. He spoke about peace between Jews and Arabs and about finding homes for both Jewish and political refugees. He opposed all forms of racial and ethnic discrimination, such as segregation. He was also an activist for world peace and democracy. Einstein realized that the scientific community can either help or hurt our civilization and believed that scientists are responsible for their actions.

If you were a superstar celebrity, how would you use your fame to make the world a better place?

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Everyday Einstein: Lasers

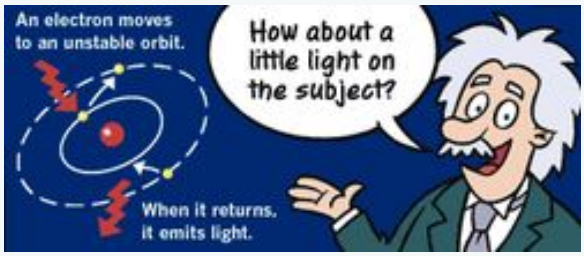
This text is provided courtesy of OLogy, the American Museum of Natural History's website for kids.

Einstein's work helped in the making of many things! Here's how his ideas led to lasers:

Illustrations courtesy of Daryll Collins

Before Einstein

Scientists pondered the nature of matter and energy and how they interacted. They knew that energy comes out of matter as light, but how was a mystery...



Illustrations courtesy of Daryll Collins

During Einstein's Life

By imagining electrons being forced into unstable orbits in an atom, Einstein figured out how energy could be released by atoms. By making this discovery, he helped pave the way for the invention of lasers.

After Einstein

Illustrations courtesy of Daryll Collins

Scientists can now make the electrons in atoms all emit the same kind of energy in the same direction in a narrow beam.

What Lasers Mean to You

Did you know the word LASER stands for "Light Amplification by Stimulated Emission of Radiation"? Lasers are used in all sorts of things today, including supermarket checkout scanners, medical equipment, and CD players. A tiny laser is used to read the bumps and grooves on a CD and translate the pattern into sound.

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It's All Relative

This text is provided courtesy of OLogy, the American Museum of Natural History's website for kids.

There is no absolute, or "same," time and space. This means time and space are different for everyone! How you experience events in time and space depends on TWO important things:

1. Where you're looking from

Imagine you're sitting on a fast-moving train. You see your friend moving by you; your friend sees you moving by him or her.

2. How fast you're moving compared to the speed of light

Imagine you are still on the train and two lightning bolts flash — one in front of the train, the other behind it. If your friend sees them flash at the same time, you'll see them flash at different times. Why? Because you're moving toward the light of one bolt and away from the light of the other.

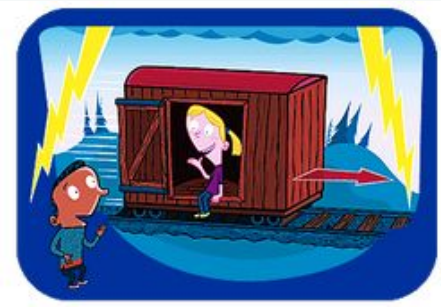

Illustration Credit: Jim Paillot

Time and space are different depending on your frame of reference.

You've just been working on a thought experiment. Einstein and others have used thought experiments to try to explain how the universe works. To perform a thought experiment, you don't need a laboratory or machines — just your imagination! Once, when someone asked Einstein where his laboratory was, he pointed to his pen.

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Light the Way

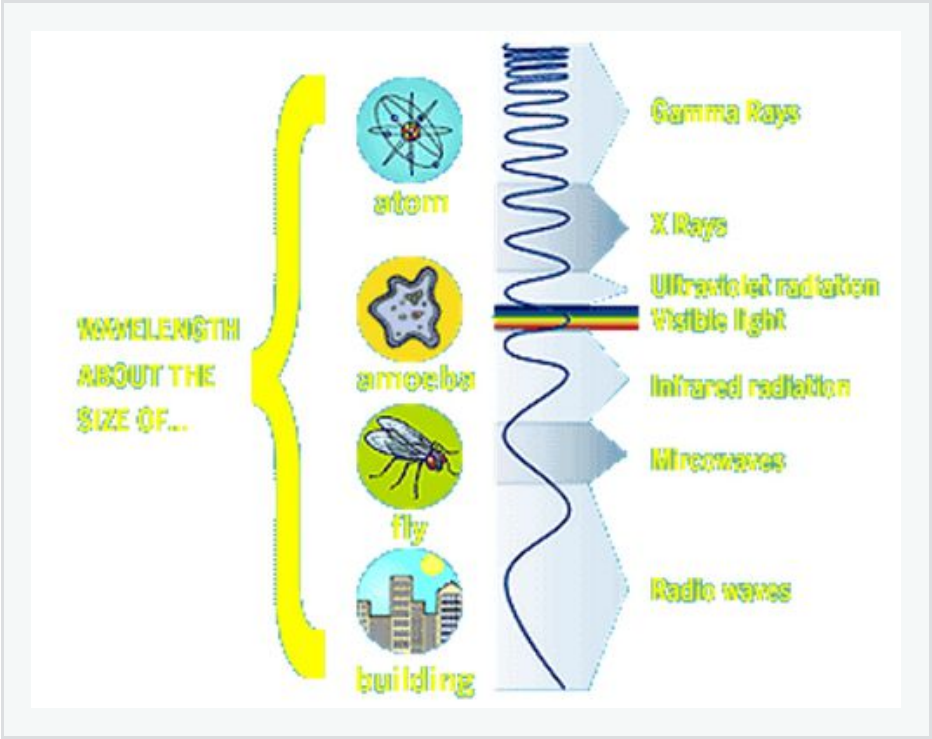
By American Museum of Natural History

This text is provided courtesy of OLogy, the American Museum of Natural History's website for kids.

What's the fastest thing in the universe? If you said light, you're right! It takes us about 6 hours to fly from New York to California. Light can go there – and back – in 1/30 of a second!

There's more to light than meets the eye!

It is a special kind of energy, called electromagnetic radiation, and it travels in waves.



Visible light waves come in different sizes: short ones look blue and long ones look red. All other electromagnetic radiation is invisible to our eyes — like the very long waves that can carry signals to radios.

Whatever the size, you won't find anything that goes faster than light. Why not? That's a light mystery that's kept scientists in the dark — so far.

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Train of Thought: Light Speed

This text is provided courtesy of OLogy, the American Museum of Natural History's website for kids.

Light is fast! It's the only thing that can reach the universal speed limit — 186,000 miles per second. (If you could travel as fast as light, the universe would look very different.) Because it moves so quickly, light can seem to appear instantaneously. Think about when you turn on a TV... images pop up right away.

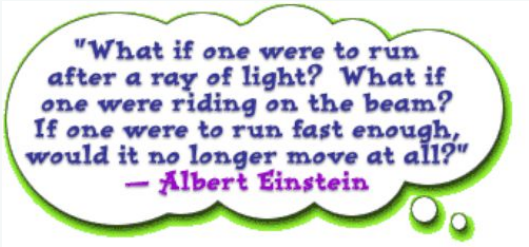
The image of the universe © American Museum of Natural History and the National Center for Supercomputing Applications, 1999

You have to be a really big thinker to imagine the size of the Universe. It's so big that light from the most distant galaxies takes over 10 billion years just to reach us on Earth! That's twice as long as Earth's been around. Everything we've ever observed in space is part of our Universe. We don't know what's beyond it or if there are other Universes out there.

How does the speed of light affect our lives and what we know about the universe? To shed some light on the subject, power up this thought experiment:

Question: What if light could only travel 1 foot/second?

Example: Imagine you are watching a live concert broadcast on TV.



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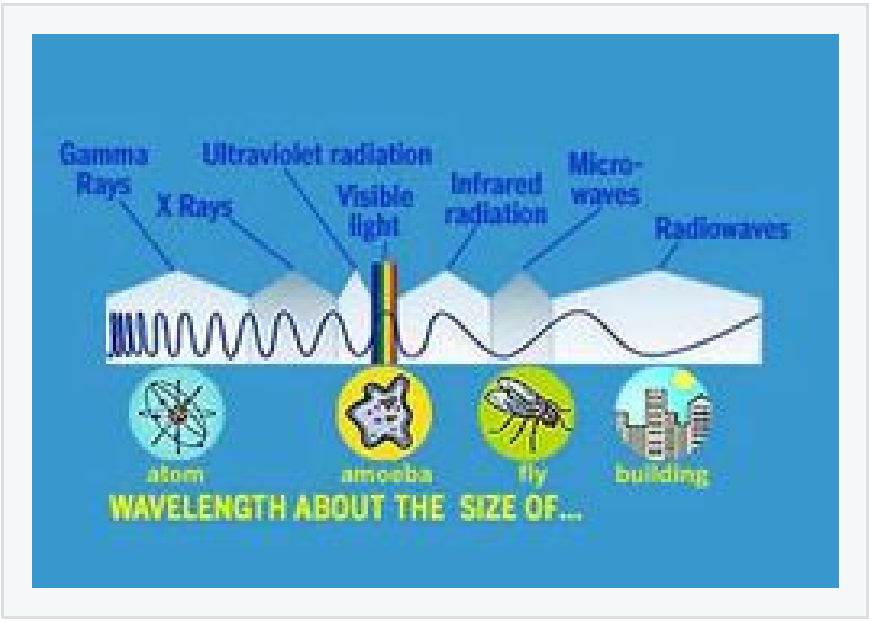
Logic: When light travels at its normal speed of 186,000 miles/second, you see the broadcast immediately. You could be 1 mile or 3,000 miles away from the concert — it doesn't matter! Why? Light can travel distances very rapidly. If you changed how fast light could travel, then you would change the amount of time it would take for it to reach your eyes.



Eric Hamilton

We see light every day -- whether from light bulbs, flames, flashlights, or the Sun (our most important source of light). We see objects because they reflect, or bounce, light into our eyes. Light is a form of energy called electromagnetic radiation. It's made of tiny particles called photons that travel in straight lines. In a vacuum, nothing can travel faster.

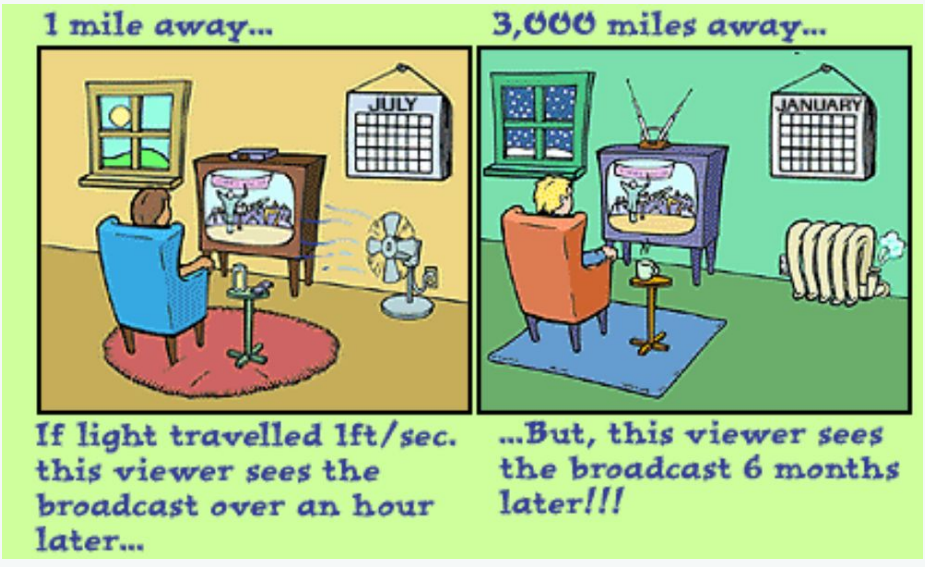


Illustration Credit: Eric Hamilton

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Prediction: If light could only travel 1 foot/second, the broadcast would reach viewers at different times, depending on their distance from the concert. Somebody sitting 1 mile away would receive the broadcast with a delay of over an hour. Somebody 3,000 miles away would receive the broadcast about 6 months later. Not exactly live TV!

Conclusion: The farther away you are from a source of light, the longer it takes the light to reach you.

Did you know? Distances on Earth are relatively short, which is why live TV can be seen anywhere on Earth at almost exactly the same time. But distances in the universe are SO great that by the time light from an object in space, like a star, reaches our eyes, what we are seeing is a snapshot of how it looked hundreds or even millions of years ago!

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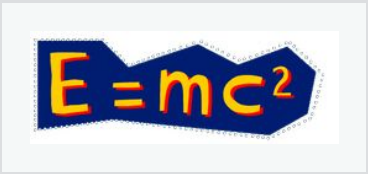
Equation Invasion

This article is provided courtesy of the American Museum of Natural History.

The world's most famous equation is probably Einstein's $E=mc^2$. Einstein made an astounding discovery about the relationship between energy and mass, and put it into this formula. What does it mean?



E = Energy

- Energy makes things happen, such as making objects move or get hotter.
- Energy often changes from one form to another. It comes in many forms, such as heat and light.

Equal sign = THE BIG THING!

- The equal sign lets us compare and connect two things that are equivalent. For example, 1 dollar = 100 pennies.
- $E=mc^2$ compares and connects mass and energy.
- $E=mc^2$ explains how much energy is in any amount of matter – the more mass something has, the more energy it has.
- Since c^2 is such a huge number, a little bit of mass contains a huge amount of energy.

m = MASS

- Mass is the amount of "stuff" an object has.
- Mass isn't connected to size.
- Same-sized things can have different masses. For example, a box of tissues is the same size as a brick. But they have different masses – and different results if you drop one on your foot!

c^2 = SPEED OF LIGHT SQUARED

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- c = the speed of light = 670 million miles per hour = 670,000,000 mph.
- In this equation, c is squared, which is 670 million mph x 670 million mph. That's a big, big number!
- c in the equation comes from the Latin word celeritas, which means "swiftness."

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Train of Thought: Newton's Ball

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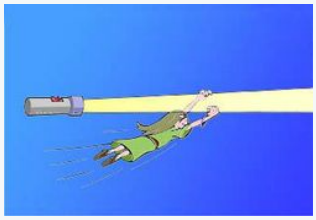

Eric Hamilton

A thought experiment is an experiment that can be described but is not actually performed. Instead, it is carried out by the mind, using reasoning and logic. Thought experiments have been used by great thinkers since ancient times, and they are still used today to explain concepts such as quantum physics and relativity. These "virtual experiments" help us explore the world.

Have you ever wondered how satellites in the sky stay in orbit? Before there were satellites, Newton asked himself the same thing about objects such as the moon:

Why do things stay in orbit?

Get your brain on the ball and explore Newton's question with the thought experiment below:

Question: Can you throw a ball so hard that it never falls to Earth?

Example: Imagine you are on a mountain and throw a ball in front of you.

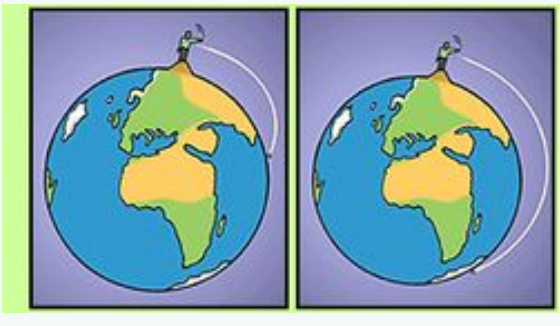

Illustration Credit: Eric Hamilton

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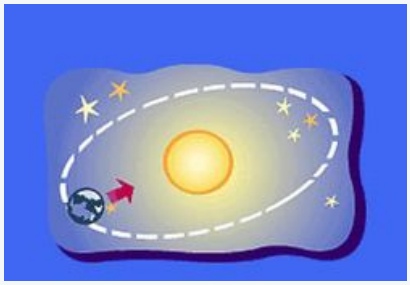
Logic: Think about what happens if you throw a ball softly. It goes a bit and then falls to the ground. If you throw the ball harder, it will go farther before it hits the ground, right?

Courtesy of NASA

The Earth is our home. So far, it's the only place that we know of that has life. Everywhere you look on Earth there is life. This is possible because Earth has lots of water. It's also just the right distance from the Sun. Some people call Earth the "Goldilocks planet." It's not too hot (like Venus), and not too cold (like Mars), it's just right!



Jim Paillot

Gravity is the force of attraction between all objects in the Universe. Objects with more mass have greater gravitational pull than objects with less mass. Gravity keeps Earth and the planets orbiting around the Sun instead of floating off into space. What would the Universe be like without gravity?

Prediction: If you throw the ball hard enough, it will never hit the ground and continue to follow a stable path around the earth. This path is called an orbit. (If something is going a certain speed around Earth, it will stay in orbit around the Earth.)

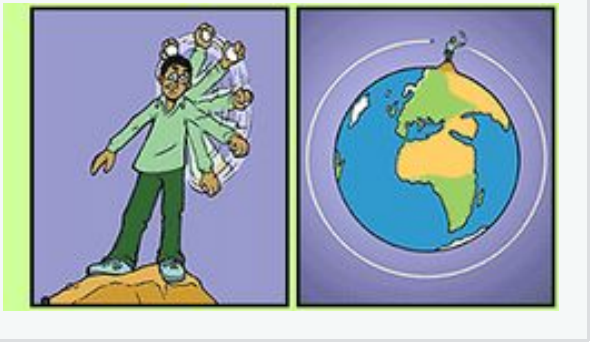
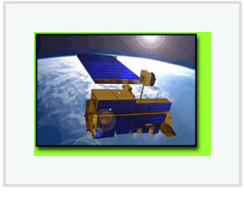


Illustration Credit: Eric Hamilton

Conclusion: By combining his theory of gravity with his theory of motion, Newton came up with a formula that showed how fast an object has to go to stay in orbit. He was right! Today, scientists use his formula to put satellites in orbit.

Who said science couldn't be a ball?



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