

### Student Guide

Study Guide  
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# The Inventors' Magic Key

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Billie has a science project coming up. She has to invent something and she just can't figure out what to do. Besides, she HATES science. What could she invent? She's just a kid. Suddenly a bumbling wizard appears, following a magic key. It seems this key shows up at just the right moment in history to help inventors in their hour of need.

So begins a journey through history, from the invention of the wheel to... well, you'll see. Along the way you'll meet Benjamin Franklin, Alexander Graham Bell and Thomas Edison and hear the fascinating stories of the people and events that made some of the world's great leaps forward. And we'll answer the questions "What is this key and how do I get one"?

So, take one part science, one part history, a lot of fun and a drop of mystery. Heat it over the flame of your imagination and "Eureka, you've got it!" *The Inventors' Magic Key!*

# Franklin

was born in 1706 in Boston, Massachusetts, the tenth of 17 children. Although he had little formal schooling he grew up to become not only one of the Founding Fathers of the United States of America but also a printer, writer, publisher, printer and inventor.

In his scientific studies, he began experimenting with electricity and the electrical phenomenon. Franklin performed his now-famous experiment with the lightning rod and offered what is called the "one-circuit theory" of electricity, positive and negative. His other inventions included the bifocal lens.

Though he received a great deal of recognition for his inventions, Franklin chose to keep them secret, choosing instead to give them to the world.

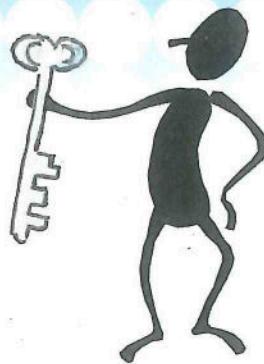


He moved to Scotland. He returned to the United States in 1724 and became a citizen in Boston.

He was able to communicate with people by telegraph. Working on the idea of a multiple telegraph, Bell and his assistant, Charles Sumner Tainter, worked on it for many years. In 1876, when the first complete sentence was sent over the wire, Bell said, "Mr. Watson, come here; I want you.". He continued to work on the telephone and the wax recording cylinder, which led to the phonograph.

## Alva Edison

Thomas Edison was born in Milan, Ohio. Thomas Edison went to work at age 12, selling newspapers and snacks on the street. He sold papers at railroad stations, learned to operate a telegraph and during his time in New York, he worked as a telegraph operator. After he made his first invention, an electric vote counter, he decided to work on things people would buy. He opened a laboratory in Newark, New Jersey, where he worked to improve telegraphy and type-writers. He invented the carbon transmitter, which made Alexander Graham Bell's telephone practical. In 1876, he moved his laboratory to Menlo Park, California. He invented the first phonograph (1877) and the first practical incandescent electric light bulb. Many other inventions (he would end up with 1,093 patents) led to his being known as the 'Wizard of Menlo Park'. One of his many inventions was the motion picture projector.



## Think like an inventor!

Many inventors find things that happen in their daily lives that cause them to think of some problem in a new way. The inventor of VELCRO® thought of his invention while removing burrs from his pet's fur after walking in the woods. Eli Whitney watched a cat pull feathers through a cage. It caused him to dream up the invention now known as the cotton gin. Other inventions come about when their inventors try to think of uses for things - vulcanized rubber for tires came about that way. Have you heard of "yellow stickies" (PostIt®)? They were the result of a "failed" adhesive experiment which was too weak to market, until the chemist figured out that a weak adhesive had good uses too.

You can come up with a solution for a problem (or find a problem that fits your solution!) by either "turning a problem around" or selecting two or more things at random and using them to "seed" new ideas. What does "turning a problem around" mean? It means looking at it from a different angle or thinking about it in a new way. Here's two examples:

- **Example 1** - Instead of thinking of shoes protecting your feet from the ground, think of using something to protect the ground from your feet.
- **Example 2** - Instead of thinking about how you can carry kumquats home from a store, think of how they can come to you (either by delivery or growing your own) or if you need kumquats at all.

From "How Did They Think of That?" online article  
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[http://inventors.about.com/library/inventors/blkidprimerk\\_6.htm](http://inventors.about.com/library/inventors/blkidprimerk_6.htm)

# Glossary

**battery** - a group of two or more cells connected together to provide electrical current. Sometimes also used to describe a single cell which converts chemical energy to electrical current

**conductor** - usually a metallic substance capable of transmitting electricity with little resistance. The best conductor at normal temperature ranges is silver. The most common conductor is copper. Some recently discovered substances called *super conductors* actually have zero resistance at extremely low temperatures.

**current** - the flow of electricity, commonly measured in amperes

**deductive reasoning** - reasoning from the general to the particular

**electricity** - a form of energy that is found in nature but that can be artificially produced by rubbing together two unlike things (as glass and silk), by the action of chemicals or by means of a generator

**experiment** - a procedure or operation carried out under controlled conditions in order to discover something, to test a hypothesis, or to serve as an example

**filament** - a wire (as in a light bulb) that is made to glow by the passage of an electric current

**ground** - an object that makes an electrical connection with the earth

**hypothesis** - a proposal intended to explain certain facts or observations

**inductive reasoning** - reasoning from detailed facts to general principles.

**invention** - something invented; especially, an original device or process

**lightning rod** - a metal rod set up on a building or a ship and connected with the earth or water below to decrease the chances of damage from lightning

**resistance** - the characteristic of materials to oppose the flow of electricity in an electric circuit

**scientific method** - the rules and procedures for the pursuit of knowledge involving the finding and stating of a problem, the collection of facts through observation and experiment, and the making and testing of ideas that need to be proven right or wrong

**theory** - a general principle or set of principles that explains facts or events of the natural world

# "Can two cans and a string really be used to talk over a distance?"

The old "two cans and a string" technique (or better yet, "two paper cups and a string") really does work. The key is to make sure that the string is tight between the two cups and this normally means that the distance is limited and the two people have to be connected to each other by a straight line. But as long as the string is tight, it works. It's also a great way to understand how telephones and radio work.

To try it, take two large paper cups and punch a tiny hole in the center of the bottom of each with a sewing needle. Take a piece (perhaps 100 feet [30 meters]) of non-stretchable thread or kite string and thread each end through each hole. Knot or tape the string so it cannot go back through the hole when the string is stretched. Now with two people, have each one take one of the cups and spread apart until the string is tight. If one of you talks into one of the cups while the other listens, the second person should be able to hear what they say.

Here's why it works. When one person talks into his/her cup, the bottom of the cup vibrates back and forth with the sound waves. Imagine the bottom of the cup moving back and forth very quickly (1,000 times per second or more) with the sound waves of the speaker's voice. The vibrations travel through the string by pulling the string back and forth. Therefore, the bottom of the second cup should start to vibrate back and forth just like the bottom of the first cup is vibrating, producing sound waves. The second person can hear the sound waves and can therefore hear what the first person says.

This isn't much different from how a telephone works, except that electric current replaces the string in a telephone. In an old-style telephone, the person speaking vibrates a metal diaphragm. The diaphragm's vibrations rapidly compress and uncompress carbon granules, changing their resistance. A current passing through the granules is strengthened or lessened by the changing resistance. At the other end, the rapidly changing current runs through a speaker and causes its diaphragm to vibrate back and forth, so the second person hears the first person speaking.

From the online article "Can two cans and a string really be used to talk over a distance?" June 27, 2000  
<http://science.howstuffworks.com/question410.htm>

