

How do radios work?  
How do toilets work?  
How does root beer work?  
What does 10W30 mean?  
How do light sabers work?  
Is it inflammable?  
Is it a 3 problem?



Fast, Fun, Fact-Filled!

## How Stuff Works Express

Marshall Brain's newest, coolest online publication

Articles

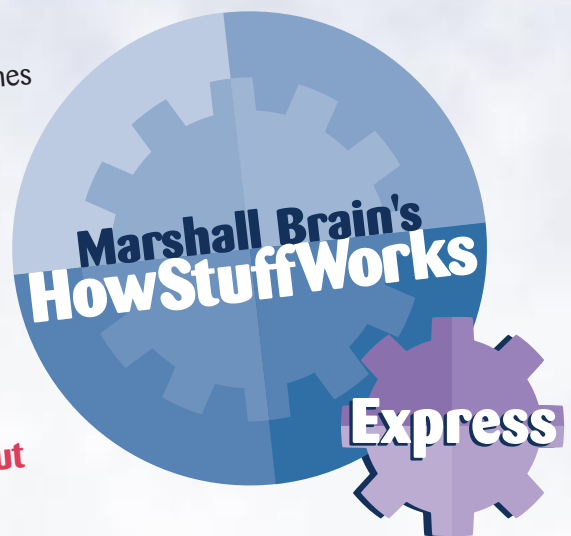
Puzzles & Games

Experiments

Activities

Homework

Help



Stuff -  
From the  
Inside Out

[www.express.howstuffworks.com](http://www.express.howstuffworks.com)

**Teachers!** Go Online for worksheets, teacher keys, curriculum links and end-of-grade tests

**Express**

**WIN**

cool stuff!

see page 4 for details

# How CDs Work

INSIDE THIS ISSUE:

PAGE 3 Toy Autopsy

PAGE 6 Express Quest

PAGE 8 SciTech on TV

PAGE 15 Hot Sites - Cool Books

+ MORE GREAT STUFF!





## Kids learn better in a school of dolphins.

### AdventureOnline.com offers real adventures in learning that kids love —

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[www.AdventureOnline.com](http://www.AdventureOnline.com)



heySmarty.com

Get your homework done. Fast.

heySmarty.com

## LISTERICAL

Each list has four correct answers and only one wrong answer. Can you figure out which answer doesn't belong?

### Songs by Britney Spears

Soda Pop  
Reflection  
Sometimes  
Stronger  
Lucky

### Endangered Animals

Tiger  
Gorilla  
Giant Panda  
Rhinoceros  
Buffalo

### Common Internet Terms

Bandwidth  
Domain  
Usenet  
Frequency  
Cookie

### United States Lakes

Hudson  
Tahoe  
Pontchartrain  
George  
Superior

### Characters in the TV Show Felicity

Ben  
Julie  
Matt  
Elena  
Meghan

### Currencies of the World

Ruble  
Yen  
Peso  
Euro  
Duma

## CRYPTOGRAM

Each letter stands for a different letter in the alphabet. Can you break the code to read this message?  
(Hint: In this puzzle, Y=T and T=O)

Y T C E D O E Y , S T H E O O B L Z T T B

C F L Z C E L Y C T E L E B L M C P O T N K H E W .

## GO FIGURE

Can you figure out what color each person wore on Friday?

On Friday, Jane, Mia, Todd, and José each wore one of the following colors: red, blue, yellow, or green.

They each wore a different color that day. Neither Jane nor José ever wears the same color two days in a row. When Jane wears green or red, José always wears yellow or blue the next day. Todd wore red on Monday. Mia only wears blue every other day. On Friday, Todd did not wear blue. On Thursday, Jane wore green and Mia wore blue. The only colors Todd ever wears more than once in one week are blue and yellow. Todd wore green on Thursday.

**Can you tell who wore which color on Friday?**

Use the above chart to help you solve the problem.

Help: This chart may look confusing, but it's really here to help you. If you find that one person could not have worn a certain color on Friday, put an X under his/her name, across from that color. Once you find out what color someone wore on Friday, put a dot under his/her name, across from the color. Then, put an X under everyone else's name, across from that color (because no one else could have worn that color), and an X across from every other color under that person's name (because that person couldn't have worn any other colors). This will help you see the problem more clearly. You may want to start by filling in information for Todd first.

	José	Jane	Mia	Todd
Red				
Blue				
Yellow				
Green				

## WHAT'S THAT YOU SAY?



### Win a Blimp!

Can you figure out what this contraption is? Submit a guess by e-mail and you'll automatically be entered to win one of five, cool remote control blimps from Plantraco. Guesses don't have to be correct to win...be creative! Send your entries to: [blimp@express.howstuffworks.com](mailto:blimp@express.howstuffworks.com). Entries must be received by midnight, November 15, 2000 (EST). There is a limit of five entries per e-mail address. Winners will be drawn at random and notified by e-mail.

**We'll publish the best entries in our next issue!**

## SEARCH-A-WORD

Can you find the hidden computer-related words & phrases?

F Q Z T W R C V A S L Y X V Z O X M L H  
L M L I X A H Y D A R M Z S V G Y U S L  
U A M M G E L X T O Y G J Y V C O V P J  
J I J I C I Y I T O R M J O A G O F X L  
G D Q Z L Y G A H S O H I T L D Z N Q C  
E B I B K I M A W T M L F L O P P Y E D  
R O U F D R A O B Y E K B U L T H R W D  
S S R H O L D B L Y M N F A S Q A I W A  
H D O F A N S T M F T U R F R E L Z T O  
K Z O F I O K C U T N E E E H C A C I B  
K R O W T E N W L C H S V D T L H E W V  
D W A B N W H L T P D A I U X N P I K V  
B T O S J L A I I M S B R E Z Z I P V F  
T L C U R S O R M N Q A D D T W X C E E  
O D L R L N E A E V E T I A W E E Y P R  
N P Q I W P R E D O Y A G R S A L X R N  
G T L V A G R J I Z E D B Q R O R E A M  
E G E A O C Q L A P T O P O T K S E D J  
F I W R S S R Z J L J P G N N I D V W H  
G P P H Q M U G V V N E D Q T I D Q M X

ARCHIVE	DESKTOP	FUNCTION	MEMORY	PROGRAM
CACHE	DIGITAL	GIGABYTE	MULTIMEDIA	SCREENSAVER
CURSOR	DOWNLOAD	HARDWARE	NETWORK	SOFTWARE
DATABASE	DRIVER	INTERNET	ONLINE	TOOLBAR
DEFAULT	FLOPPY	KEYBOARD	PERIPHERAL	VIRUS
DELETE	FORMAT	LAPTOP	PIXEL	WINDOWS

## EXTRAORDINARY PEOPLE

*Julia Morgan is considered to be the most important woman architect in history... even though she lived in an era when women were not supposed to be architects at all! Her story is one of great determination, overcoming tremendous obstacles to attain her goal.*

Julia Morgan was born in San Francisco in 1872, nearly 130 years ago. As a child, she had a strong curiosity about both the arts and mechanical things. She loved learning about how things work. In 1890, when she graduated from high school, it was typical for girls of her social class to get married immediately and join "high society." But Julia was not interested in that life. So she convinced her mother to let her attend the University of California at Berkeley, which had just recently begun to enroll women. During her second year, she enrolled in the Civil Engineering Department. She was a trailblazer — Julia was the only woman studying engineering in the whole university. She faced many hurdles. Some men in her department resented her, made rude comments and played nasty pranks.

But she worked very hard and would not be deterred. In 1894, Julia Morgan became the first



**Julia Morgan**

*Pioneer Architect*

woman to graduate from the University of California with a degree in Civil Engineering.

While this was an impressive start, Julia's story had just begun. After she graduated, Julia was fortunate to hear a famous architect speak and thought that being an architect would be a

natural fit for her. To become an architect, however, she needed much more training. So she decided to battle the odds once again and apply to a famous architectural school in Paris, called the Ecole Nationale des Beaux-Arts. It was

---

*In 1894, Julia Morgan became the first woman to graduate from the University of California with a degree in Civil Engineering.*

---

where many of Europe's most famous architects had been taught. But behind its iron gates, the school was not very welcoming to Americans... especially women!

In the late 19th century, Paris was known as the cultural and intellectual center of Europe — a perfect setting for a young American woman who was ready to challenge the old way of doing things. In 1896, with great anticipation, Julia Morgan walked through the gates of the famous university and presented her application. But her hopes were dashed. She was told that women were not allowed to take the entrance exam. She strongly protested, insisting that she could meet all of the academic demands. But the school's administration would not change its answer and she was sent away.

Julia walked the Parisian boulevards wondering if she should give up her dream and go back to America. But, as she looked at the exquisite designs of the old Parisian buildings, she decided that she would find a way to get into the Ecole des Beaux-Arts. She didn't know how and she didn't know when, but she knew she would succeed.

She hoped that by gaining experience and the support of a local architect, her chances for acceptance would improve. Julia found a job as an apprentice to a Parisian architect, learning the basics of the trade. After a year she was finally allowed to take the entrance exam. She did well. In fact, her results would have gained admission for a man. But, once again, she was not accepted. Her test was graded much more strictly to discourage women from attending the

*continues on page 18*

LETTER FROM MOTHER

**Have you ever wondered** how your television displays pictures or how they make the software for computer games?

Ever since I can remember, I've enjoyed taking stuff apart to figure out how it works. When I was twelve, I tore my bicycle apart... and I never quite got it back together! But it really helped me understand how it worked and I still remember how exciting it was to see how everything fit back together (with a little help from my father). Eventually I went to college and became an electrical engineer so I could learn how to build computers! We started How Stuff Works Express with the hope that you'd catch that same excitement.



**Marshall Brain**

Since this is our first issue of How Stuff Works Express, we are doing the same thing you would do the first time you try

something — we are figuring out the best way to do it. To really make it great, we need your help. Tell us what you like and, most importantly, tell us what we can do to make it even better. What topics would you like us to feature? Do you have ideas for new sections? Go online and enter this address:

**[www.express.howstuffworks/comment](http://www.express.howstuffworks/comment)**. Tell us what you think and we will read every one. You'll be surprised at the power you have!

THE COOLEST THING YOU'LL NEVER SEE...

**Did You Know That:**

Rotation of the Earth creates jet stream winds which:

- flow 7 miles above the earth
- range in speed from 57 mph - 250 mph
- are "surfed" by hot air balloonists trying to circle the globe
- help airplanes save fuel and decrease flight time when flying east

**Learning Focus:**

- To learn Internet skills
- To learn weather basics with science, geography and math connections

**Do the project online:**

[www.express.howstuffworks.com/quest/jetstreams](http://www.express.howstuffworks.com/quest/jetstreams)

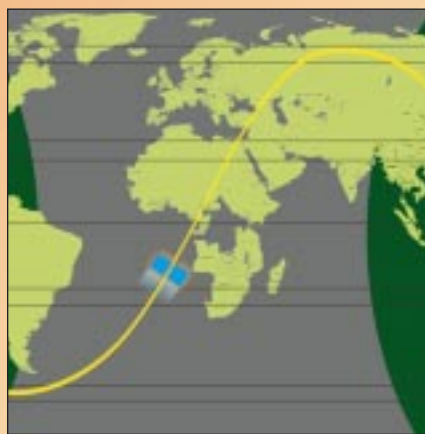
# Jet Streams

# HOTSPOTS

## Sandlot Science

[www.sandlotscience.com/](http://www.sandlotscience.com/)

Cool! Interactive! Try more than 80 optical illusions such as Impossible Staircase, Twisted Cord and Moon Illusion. Learn how they work. Bet you can't do just one!



## NASA J-Track

<http://liftoff.msfc.nasa.gov/toc.asp?s=Tracking>

Select and track dozens of space objects in real time. Follow the Space Shuttle, the new Space Lab or the Hubble Space Telescope as they orbit the Earth. Watch continents go from sunlight to darkness. Check out the awesome 3-D version!

## A Science Odyssey

[www.pbs.org/wgbh/aso/](http://www.pbs.org/wgbh/aso/)

You'll find lots of interesting things at this site. Go to "Technology at Home," slide the date button and watch the living room change before your eyes! Compare today's stuff with what our parents and grandparents had. Probe parts of the brain, learn how radio transmission works and compare science knowledge in 1900 to what we know today.

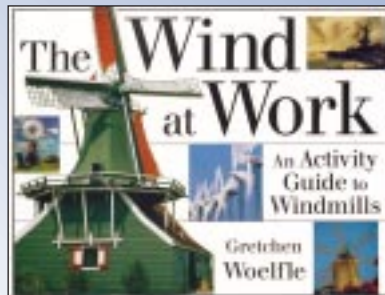


## Uselessknowledge.com

[www.uselessknowledge.com /index.shtml](http://www.uselessknowledge.com/index.shtml)

Over 20,000 trivia facts, quotes and quizzes. You'll spend hours learning useless stuff... but it's fun! As they say, if it isn't here, it isn't trivia.

# BOOKS



## The Wind at Work: An Activity Guide to Windmills, Gretchen Woelfle

More than 500 years before Columbus set sail for the new world, windmills were whirring away as a clean and economical source of power. In *The Wind at Work*, Ms. Woelfle takes the reader on a fascinating journey through

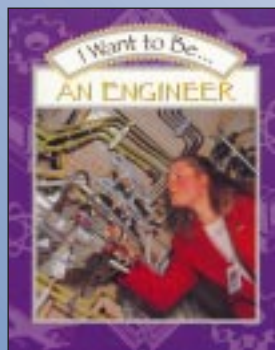
the history of windmills—from their earliest invention in Persia right through to modern times. Learn what it's like to have a career as a "windmiller," and discover where the term "rule of thumb" comes from. The text is lively and the book is well illustrated, including many historical photographs. There's even a list of windmill locations so, with some luck, you can see one in action!

## Inventions Explained: A Beginner's Guide to Technological Breakthroughs (The 'Your World Explained' Series)

Richard Platt



This exciting book is filled with photos and drawings of many of the most important inventions in the world. Starting with tools and weapons from over two million years ago and working up to current technology, you'll learn about lots of new technologies that have had a huge impact on everyday life. Which building has the largest roof in the world? What does it look like inside a nuclear fusion reactor? You'll find answers to these questions and many others.



## I Want to Be an Engineer, Stephanie Maze

Do you like to build things? Solve problems? Try to make things work better? Ask an engineer these questions and you are likely to get an enthusiastic yes, yes, yes in return! Engineers are part technician, part scientist and part inventor. If this sounds as exciting to you as it does to us, then we recommend you read *I Want to Be an Engineer*. There are many kinds

of engineers: agricultural, environmental, electrical, computer and construction engineers... just to name a few. From designing cars to the roadways they travel on, to the latest special effects in movies, you'll see what it's like to be an engineer and how to become one.



## OCTOBER 1-31, 2000



Sunday, October 1 - 8:00 pm (2 hours) (CNBC)

**NATIONAL GEOGRAPHIC EXPLORER**

**Living with Gorillas**

Join Magdalena Bermejo, a Spanish scientist, in the Congo Basin as she sets up camp to study a family of silverback gorillas. Learn about Apollo, a noble 350-pound male. In this episode, called Giants of Etosha, we also meet Knob Nose, a matriarch elephant, and her herd of 18. Learn about their migration patterns through Africa's Etosha National Park.

Monday, October 2 - 9:00 am (1 hour) (DISC)

**ASSIGNMENT DISCOVERY**

**Properties of Matter**

Discover the unique molecular structures of diamond, gold, graphite and carbon... and why this gives them value.

**The Phenomenon of Sound**

Bats! Discover how the US Navy incorporated bats into helping to improve sonar technology.

Tuesday, October 3 - 9:00 am (1 hour) (DISC) (Repeated)

**ASSIGNMENT DISCOVERY**

**Understanding Fire**

Fire was discovered 9,000 years ago. Learn the many ways fire has assisted in the advancement of nature and technology.



Tuesday, October 3 - 9:00 pm (1 hour) (PBS)

**NOVA**

**The Brain Eater**

Mad-cow disease, a highly infectious and incurable disease, has claimed the lives of nearly a million cattle — and a few humans as well. Join the NOVA team as they race to unscramble this mystery.

Wednesday, October 4 - 9:00 am (1 hour) (DISC)

**ASSIGNMENT DISCOVERY**

**Understanding Cars**

Follow the evolution of the American automobile and its impact on our society. What does the future hold?

**Heat and Temperature**

What are the differences between Fahrenheit, Celsius, and Kelvin? Why are different temperature scales so important?

Thursday, October 5 - 9:00 pm (1 hour) (DISC)

**ASSIGNMENT DISCOVERY**

**Roller Coaster Physics**

Buckle up! Learn how friction, potential energy, gravity and acceleration come together for a breathtaking ride.

**Science of Super Sight**

See what could never be seen before! Breakthroughs in visual technology allow us to glimpse the previously unseen, from galaxies to the smallest details of our skeletal system. How is this possible?

Friday, October 6 - 9:00 am (1 hour) (DISC)

**ASSIGNMENT DISCOVERY**

**Understanding Magnetism**

Magnets are simple, right? Learn how these devices affect so much of our daily living, from TVs to computers and well beyond.

Friday, October 6 - 8:00 pm (2 hours) (CNBC)

**NATIONAL GEOGRAPHIC EXPLORER**

**Search for the Battleship Bismarck**

Join Dr. Robert Ballard, an underwater explorer, as he reinvents the dramatic demise of the battleship Bismarck. Discovered in the depths of the North Atlantic Ocean, the wreck has revealed new evidence about this great German warship and a critical naval battle of World War II.

Saturday, October 7 - 6:00 pm (1 hour) (PBS)

**NATURE**

**Wisdom of the Wild**

From ancient times to modern, human lives have been influenced by animals. Discover some of the surprising ways in which animals help teach, heal and strengthen people in body, mind and spirit.



Sunday, October 8 - 8:00 pm (2 hours) (CNBC)

**NATIONAL GEOGRAPHIC EXPLORER**

**Tsunami: Killer Wave**

CRASH! Without warning, waves measuring over ten stories high crash with devastating force. See heart-stopping footage of catastrophic tsunamis and remarkable stories of heroism and survival.

Monday, October 9 - 9:00 am (1 hour) (DISC)

**ASSIGNMENT DISCOVERY**

**Tobacco Wars: Smoked Out**

What has so many Americans all fired up? Get the facts about cigarette addiction and learn about the health effects of smoking.

## Calendar Updates

Sci-Tech on TV is updated monthly. Check local schedules for program times in your area. For the latest schedule, check online:

[www.express.howstuffworks.com/scitechtv](http://www.express.howstuffworks.com/scitechtv)

*Programming note: Assignment Discovery (Discovery Channel) features a different thematic series each week. Subjects covered include energy, health, earth science, life science and ancient civilizations. The programs are commercial-free and are repeated three additional times throughout the fall and early winter.*

Tuesday, October 10 - 9:00 am (1 hour) (DISC)

**ASSIGNMENT DISCOVERY**

**Never Too Thin**

Thin is in! Is it a choice or is it simply one's genetic makeup? See how possible genetic and chemical links can provoke eating disorders.

Wednesday, October 11 - 9:00 am (1 hour) (DISC)

**ASSIGNMENT DISCOVERY**

**Understanding: The Amazing Brain**

Unlock the mysteries of the brain. Why do you think the way you do? Amazing!

Thursday, October 12 - 9:00 am (1 hour) (DISC)

**ASSIGNMENT DISCOVERY**

**An Inside Look: Broken Bones**

How do broken bones repair themselves? Discover the secrets of calcium and collagen — and why they are so critical to the process.

**An Inside Look: Heart Attack**

Call a plumber - we're all blocked up! What's the difference between "bad" cholesterol and "good" cholesterol? What can it do to your heart and how can we reduce heart attacks?

Friday, October 13 - 9:00 am (1 hour) (DISC)

**ASSIGNMENT DISCOVERY**

**Intimate Universe: Raging Teens**

From girl to woman — puberty is a time of great change within our bodies. Take a look at an adolescent girl as she transforms over an 18-month period of time — from her muscles and bones, to the onset of menstruation and sexual maturity. Fascinating!

Friday, October 13 - 8:00 pm (2 hours) (CNBC)

**NATIONAL GEOGRAPHIC EXPLORER**

**Fire!**

Hundreds of fires - and millions of scorched acres. Follow the best firefighters in the world as they test their physical limits trying to save our national wilderness during one of the worst fire seasons on record.

**Combat Cameramen**

Is a picture worth a thousand words? How about your life? These cameramen paid the ultimate price to capture footage of World War II.

**Air Boss**

"It's like flying into a black hole!" Stripped of all depth perception

after hours of flight, pilots must

land on a tiny strip of steel float-

ing in a huge ocean. Most

wouldn't make it if it weren't for

the precise and reassuring com-

mands from the "Air Boss."

Learn how pilots maneuver

multi-million dollar aircraft within

inches of each other on and off

the deck of a U.S. Naval aircraft

carrier, based solely on the com-

mands of the "gods of the flight

deck."

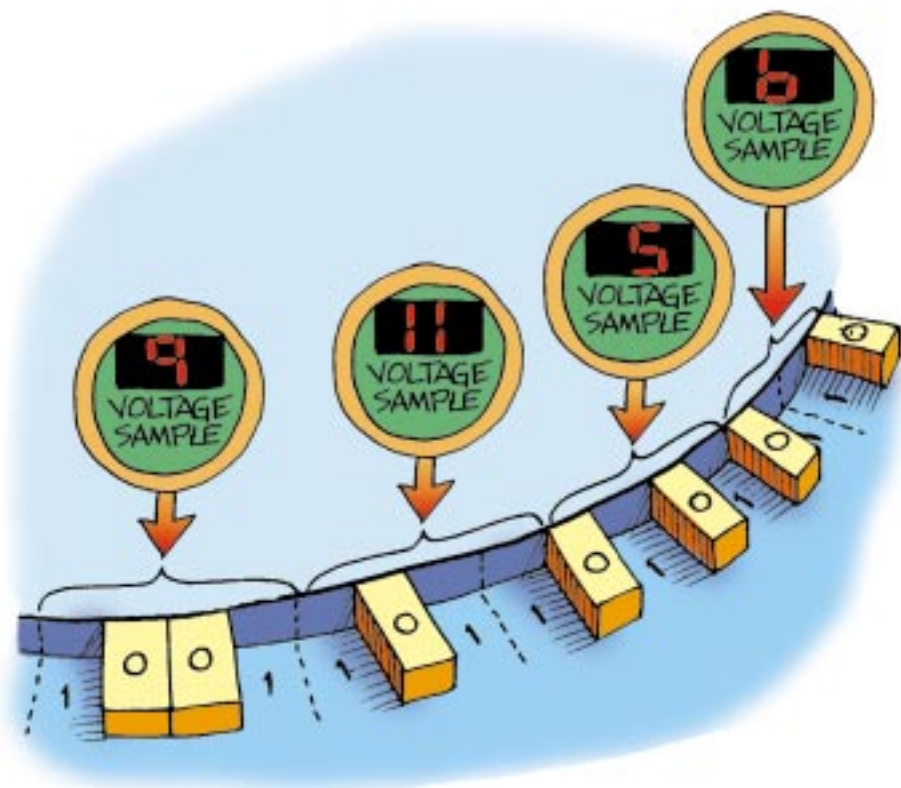
**Rodeo Clowns**

Find out how dead serious a

Rodeo Clown's responsibility is

— and that's no bull!





Voltage samples (base ten value) from 4-bit codes

convert that to a value we can all understand.

	Position of Number			
<b>Base 2</b>	1	1	0	1
	—	—	—	—
<b>Base 10 Value</b>	8	4	2	1

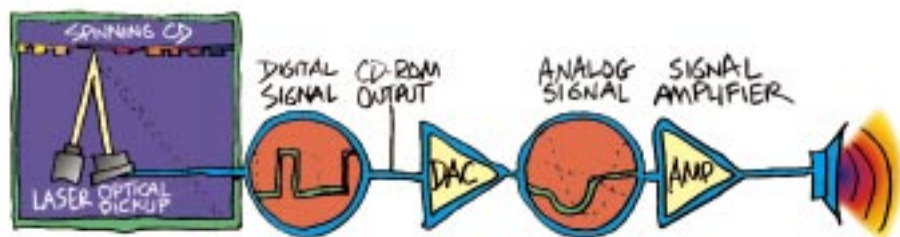
For example, a four digit code of 1101 is  $1 + 0 + 4 + 8 = 13$ .

**Remember to start from the right and work to the left.** Look at the side table (Cracking the Code) and the graphic above to see if you can crack the 4-bit “binary code.”

In the CD player, each string of 1s

and 0s corresponds to an electrical signal (a voltage). The DAC (digital-to-analog converter) turns the numbers into voltages. The voltages change 44,000 times per second! The amplifier sends the voltages to the speakers where they turn into a series of sounds. The graphic below shows how ones and zeros turn into voltages for the amplifier.

There is a good bit of computer technology inside your CD player. It converts the ones and zeros into understandable data blocks. These data blocks then go to the Digital-to-Analog-Converter (DAC), on to the amplifier and finally to the speakers. And all this is done in only nanoseconds!



Inside your CD player – From CD to sound

## Oops!...You Made How Much?

Britney Spears CD “Oops!... I Did It Again” was the fastest selling CD by a female recording artist ever. It sold 1,319,000 CDs the first week, and broke the record previously held by Mariah Carey. So how much did Britney make the first week? While we don’t know the exact amount, we can make some estimates based on averages for the recording industry. Let’s use the following information and you can do the math!

<b>Cost of the CD</b>	<b>\$17.00</b>
<b>Packaging Cost</b>	<b>4.25</b>
<b>Royalty Rate for Performing Artist</b>	<b>.16</b>
<b>First Week Sales</b>	<b>1,319,000</b>

Use the following formula for your calculations:

$$(\text{Cost of CD} - \text{packaging cost}) \times \text{royalty rate} \times \text{CD sales} = \text{Artist Royalties}$$

See page 18 for the answer.

Sources: [www.ascap.com/artcommerce/money-recording.html](http://www.ascap.com/artcommerce/money-recording.html)  
[www.yfshomepage.com/music/britney.html](http://www.yfshomepage.com/music/britney.html)



## A Rainbow of Colors

Have you ever noticed the rainbow of colors when you tilt the shiny side of a CD back and forth? What makes this happen? Here’s a quick explanation. CDs without data tracks are perfect mirrors. But the data tracks cause microscopic changes to the surface of the CD and make it act like a prism. Light rays bend (diffract) when they reflect off of the surface, and separate into different wavelengths. We see each wavelength as a different color.