March 2016

2025 Labs kids

the engineering and technology source for kids

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Engineering in the News™ For Kids!

Magazine for Kids: The Computing Issue

Computing around the world

Look inside for activities and puzzles

How does the Internet work?

Seattle, Washington is home to well-known companies like Amazon, Microsoft, Code.org, and Expedia. Many Silicon Valley companies have Seattle offices as well. Not only that - the University of Washington has one of the best Computer Science programs in the country, according to US News and World Report rankings.

You may know Washington, D.C. as our nation's capital. It is also a hub for high tech companies such as LivingSocial. And, the ARPANET, the precursor to our modern Internet, was funded out of the Pentagon's advanced research organization there. So, we can thank the country's leadership for our ability to tweet and share photos on Instagram!

New York City (NYC) is included on many lists of US high tech centers. In 2013, nearly 7000 tech companies in New York City provided more than 100,000 jobs. In 2015 alone, more than $7 billion of venture (startup) funding was invested in NYC-based startup companies. In fact, the increase in 2015 NYC-area venture funding was greater than any other region.

Silicon Valley in California is known all over the world for its technology businesses. Silicon Valley cities are home to companies such as Google, Facebook, Adobe, and Intel. The second computer on the early internet was at the Stanford Research Institute (SRI) in Palo Alto, a city in the northern part of Silicon Valley. In addition to many large tech businesses, Silicon Valley has a huge startup economy.

Forbes magazine lists the Los Angeles area as a fast-growing area for startups. The area received more than $5 billion in startup funding in 2015. LA is historically important, too. Two of the first computers on the early internet were in the greater Los Angeles area at two of California's flagship public universities: one at UCLA, and one at UCSB.

Austin, Texas has seen incredible growth in tech industry jobs, creating technology jobs at a higher rate than anywhere else in the country, according to a recent Forbes list. Companies with a presence in Austin include Dell, IBM, and Oracle.

San Francisco, California is north of what is typically included in Silicon Valley. Recently, though, it has become a hot spot for new technology companies, with firms like Twitter, Pinterest, Uber, Square, and DropBox calling San Francisco home.

Other high-tech hubs include Chicago, Portland, Raleigh, Vancouver, Toronto, Berlin, Sao Paulo, Tokyo, Seoul, and more. In fact, even experts have different opinions as to which cities are the "best" technology centers. They use different criteria to rate each city. Some criteria used are: the total number of tech jobs; the growth rate of tech jobs; the number of new startups; the amount of startup funding invested in the region; regional housing costs; and more.

Many US companies locate their European headquarters in Dublin, Ireland. Among the reasons: a low tax rate for businesses (12.5% versus 39% in the US), a well-educated and talented work force, a set of laws that do not create much extra work for businesses. In addition, Dublin has a much lower cost of living (such as housing expenses) compared to expensive places like London and Silicon Valley.

London's technology industry is growing quickly, thanks to government investment in developing an area rich in startup support and tech infrastructure. According to the Boston Globe, London has the highest rate of startup companies in Europe.

Boston, Massachussetts has been a high tech hub for a long time. A Boston-based company (BBN) and a Boston area university (MIT) created technology that implemented the early Internet as part of the ARPANET work funded by the Pentagon. The Boston area still has many technology companies and lots of startup activity, receiving more than $6 billion in startup funding in 2015.

Tel Aviv, Israel is not big, but it is an emerging technology center with a thriving startup scene. According to the BBC, high tech exports amounted to about $18 billion per year, and about 45% of Israel's exports. There is so much startup activity that there is one startup for every 431 residents.

Shenzhen, China was a fishing village 30 years ago, but is now a high tech world power. Shenzhen makes much of the world's computing devices like smart phones and computers. Taiwan and Hong Kong firms were first to begin manufacturing in Shenzhen. Then companies like Apple and Cisco began outsourcing to Shenzhen as well. It is also home to successful Chinese companies like Tencent and Huawei, and has a thriving startup environment.

Bangalore, India is well known for information technology companies to which other companies hire out (or "outsource") their work. Among these IT outsourcers: Infosys, Tata, and Wipro. Tech companies all over the world make use of IT talent from Indian companies. India hopes to move beyond outsourcing to more home grown companies.

Hong Kong, China is compared to hot startup locations like London and New York. It is considered an emerging tech hub by sources such as Forbes, Inc. In fact, Hong Kong has one of the fastest growing startup communities in the world. With only 7 million residents, a whopping 150,000 new businesses were started in 2011 alone. With its rich startup environment, it is nicknamed "Silicon Harbour" in comparison to Silicon Valley.

History of the Internet:

After World War Two, there was a period of ongoing tension between two great superpowers of that time, the United States, and the Soviet Union (Russia plus other countries that are now independent). This period of time was called the **Cold War**. The two countries competed for influence around the world.

The development of the Internet came as a result of US investment in new technologies that could connect machines, people and information to keep the country safe.

A US organization called the Defense Advanced Research Projects Agency, or **DARPA**, funded projects that would become the Internet.

They needed to figure out how to connect the computers. The telephone system already had infrastructure connecting homes, businesses, universities, and government all over the country to make phone calls.

Telephone calls were made by physically connecting a **telephone circuit** between the caller and the person being called. That physical connection is kept for the entire phone call. The traditional wired telephone network is called a **circuit-switched** network.

These telephone dial up processes were too slow to use between computers. Every time there was data to send, there would be a delay while destination was dialed.

So, they decided to make long-distance phone calls that never ended. The computer connections would be like calling your Grandma and never hanging up. This approach meant they could avoid waiting for a call to connect every time a computer had data to send.

They used a bunch of different long-distance calls between each pair of destinations. They simply connected the calls and left them connected. They had to pay AT&T for those constant connections, called **leased lines**.

They decided to break up information to be sent into pieces. Each piece of the message would be sent independently. That way, if there were problems on the network, only the missing pieces would need to be resent. The pieces of messages were called **packets**, and the approach for sending information in pieces was called a **packet-switched network**.

For example, imagine you sent an email message to a friend. It would be broken into packets, and information would be sent with each one, such as the destination (your friend) and a **sequence number** that indicates which part of the message it is. You can imagine this as something like, “Part 1”, “Part 2”, “Part 3”).

Example: Turning an email into packets

Dear Bob,

I hope you are doing well.
I’m having fun this summer!
Write back!

Sincerely,
Amy

Destination	Sequence Number	Message
Bob	#1	“Dear Bob”
Bob	#2	“I hope you are doing well.”
Bob	#3	“I’m having fun this summer!”
Bob	#4	“Write back!”
Bob	#5	“Sincerely,” “Amy”

ARPANET to Instagram

When your friend receives these pieces on the other end, the computer would put the pieces back together into the email you sent. If Part 2 were somehow lost, the computer would know that it is missing part of the email and could ask your computer to resend just that part. After Part 2 is re-sent, then she would have the entire email from you.

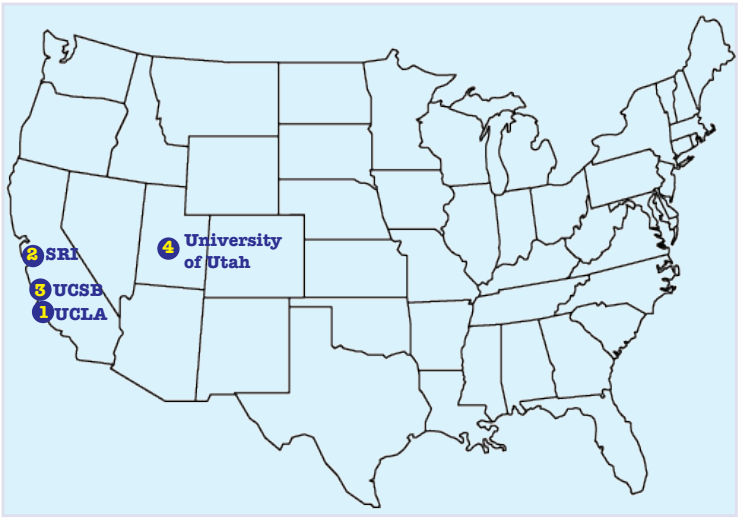
But how did the ARPANET founders specify where to send the information? With multiple computers on the network, they had to figure out how to specify the **destination** for a message.

They developed an early email program in 1971. Then they needed a way to specify not only *computer* that should receive a message, but also the *person* at that computer that should get it.

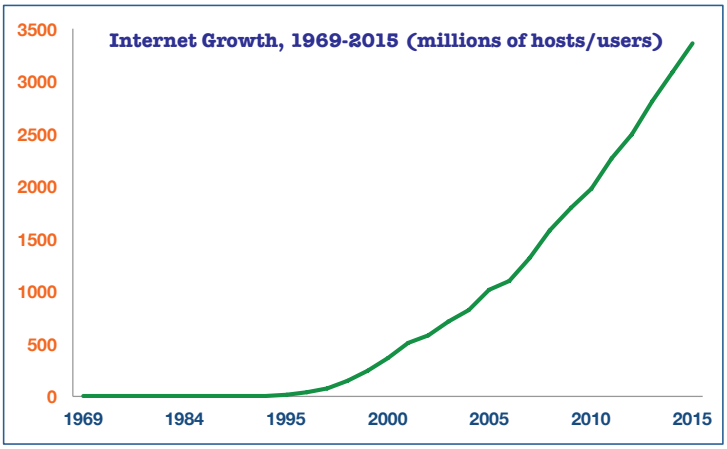
They had to come up with network **addressing**. When you send a letter to a friend through the post office, you write your friend's home address on the envelope. The internet inventors had to figure out how to specify addresses for network destinations. Early **email addresses** were very simple, like "ray@bbn". There were not many people on the network, so there were very few computers and few users at each.

The first two computers to be connected were both in California. One node was at the University of California, Los Angeles (UCLA), and the other was at the Stanford Research Institute (SRI).

By the end of 1969, four machines were on the network, and by 1975 there were 100. This early network connected mostly universities and research institutions, and was called the **ARPANET**.



The first four computers on the ARPANET, the Internet's predecessor, as of December 1969, shown in the order that they were added.



Internet growth from four computers in 1969 to billions of users in 2015.

As the internet grew, internet addressing became much more sophisticated. And with much more information being exchanged, they realized they needed separate machines to handle sending and receiving information. (They had been using the same sending and receiving computers.) They called these separate routing machines **Interface Message Processors**, or IMPs. Now we call packet routing devices **routers**.

* Sources include the U.S. Energy Information Association (eia.gov) and the Hawaiian Electric Companies (HECO).

The Internet

What is the Internet?

The Internet lets you surf the web, send an email, and talk to your grandmother on Skype or FaceTime. The Internet is a very large collection of computers and other connected devices all over the world.

In 1969, there were only four devices on the Internet (then called the ARPANET). Now there are more than **three billion** Internet users around the world.

Many of the devices on the Internet are computers - but not all. Gaming systems, smartphones, home security systems, home temperature systems, and even some cars can also be Internet-connected devices.

Internet Backbone

The Internet is made up of separate large networks that are connected together. This collection of large national or international networks is called the **Internet Backbone**.

Each large network on the Backbone is operated independently. There are network **standards** that define how they connect to each other and share information. These defined standards allow them to connect and work together across the world!

When you send an email from the US across the world, say to Japan, how does it get there? As the email travels around the globe, it crosses multiple networks on the Internet Backbone. These Backbone networks are very **high-speed networks**. In the US, companies such as AT&T, Level 3, or Sprint run these networks. Internationally, there are other providers for networks within the Backbone, like NTT in Japan, China Telecom in China, and more.

But your email doesn't go right to the Internet Backbone and then to your friend in China. Your computer will be connected to the Internet Backbone through what is called an Internet Service Provider, or **ISP**. Although some ISPs also manage parts of the Backbone, not all do. There may be multiple steps between your computer and the Backbone. Each step in the journey is called a **hop**.

So your computer somewhere in the US will get to the Internet through an ISP. There may be multiple hops on the Backbone, and if you are sending your email to Japan, it will eventually cross over into NTT's part of the Backbone. And then it will make its way to a local ISP, and finally to your friend.

Connecting Devices to the Internet

Before **WiFi** was in wide use, people used cables

How Fast is the Internet?

Internet data is sent as digital information using electrons and light. So, one important constraint on how fast Internet data can travel is the speed of light, which is **186,000 miles per second** in space. (Air has some friction, but the speed on earth is still really fast!) The circumference, or distance, around the earth is 24,901 miles. So, you would think that an Internet message might be able to get all the way around the earth in a little more than one-tenth of a second. But data gets slowed down by processing at each router along the way. This slow down is called **network latency**. The more **hops** through routers a message takes, the more latency. And, the latency changes over the course of a day based on network **traffic**. At the time of this article, it would take about 183 milliseconds, or less than two-tenths of a second, to send data between New York City and Tokyo, a distance of 6,741 miles by air. However, figuring out the actual distance those electrons would travel is harder to judge, as it depends on how the packets are routed, and where their network cables lie.

Internet of Things

How are Connected Devices Changing Our World?

The Internet of Things, or IoT, has been in the news quite a bit lately! It refers to the idea that the things we use every day will be increasingly connected. What might be connected? Think of a printer that knows when it is low on ink and automatically orders more for you. Or, a car that sends a message to your dealer's service department when it notices a problem you should get fixed. People have to create all the software to implement these smart, connected devices. People like you!

to connect their computers to their home routers, which were connected to their ISP. These days many devices are connected **wirelessly** to their home router. When you pick a WiFi network, you are picking a local wireless router that will allow you to connect and send and receive data wirelessly. WiFi is a network **standard** for connecting devices wirelessly to a local network. The standard defines how to connect, disconnect, and exchange data. Computers that network wirelessly have to follow the standard.

Many standards define how different parts of the Internet work together. The standards cover how to send and receive email messages, how to upload files, how to specify what a web page looks like, how to define a location on the Internet, and many more things. These shared standards are the reason that all these different devices and networks all over the world can work together.

Routers figure out how to send information across the Internet from **source** to **destination** using addressing information from domain names ("foo.com") or email address ("joe@gmail.com"). These logical addresses map to physical destinations, just like your street address maps to your house!

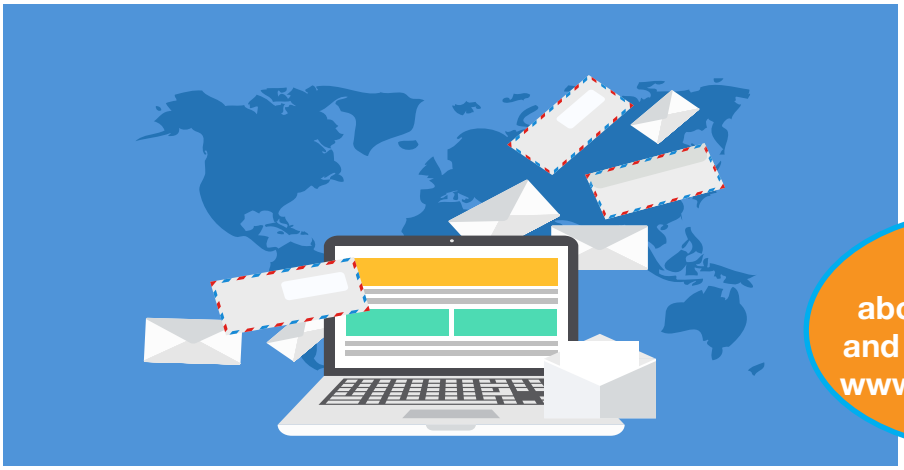
Routers

Each hop between you and your friend is connected through a device called a **router**. Routers can be small devices for local access to an ISP. They can also be complex devices for handling many, many transactions on the Internet Backbone – these are called **Backbone Routers**. For every type of network connection you can imagine, there is a router that implements that connection.

The World Wide Web

Is the **Web** the same thing as the Internet? Sort of. The Web is the part of the Internet that has web pages that are written to a particular standard (HTML) and accessible by a different network standard (HTTP). HTML stands for Hypertext Markup Language and is the way you specify what a web page has on it. In addition, you can add styling and many web site features using other standards, like CSS, Javascript, PHP, and more.

Next time you send an email to a friend, think about how it gets to them!



Read more about computing and the internet at: www.2025kids.com

Project: Python Programming

Before You Start

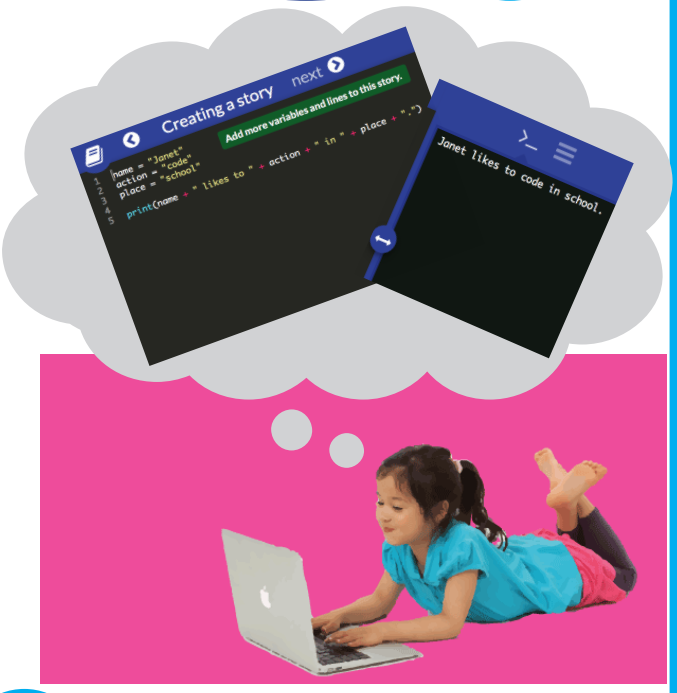
1. Make sure you have a computer with an internet connection
2. Get an adult's permission before going online
3. Get ready for some fun!

You Need:

- A computer with a web browser (Safari, Chrome, Firefox, Mozilla, etc.).
- An internet connection with access to http://www.pythonroom.com
- Permission from your parents before going online.

Notes for Parents:

- Access to this site is free, but you do need to create an account.
- The project comes from Hulaloop, and uses the Hulaloop Python learning environment ("Pythonroom").
- The Pythonroom software will guide kids through the programming.
- Kids (and parents!) do not need *any* prior programming experience or knowledge



Build Your First Python Program

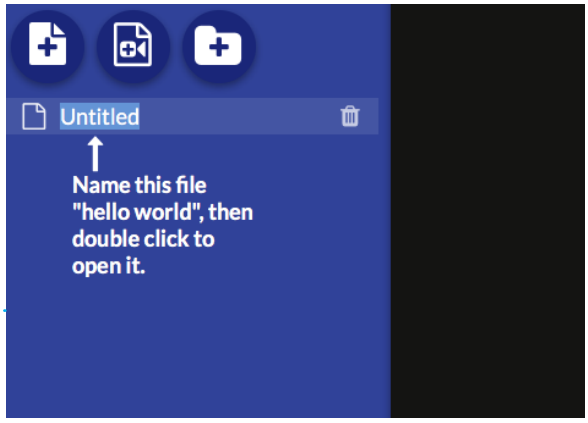
1

a. Go to https://pythonroom.com and click the **get started** button at the top.

b. Enter a user name, email, and a password, then click the "create account" button. Kids should not use their full names online. You can pick a nickname, though! Make sure a parent does this step with you.

c. Read the green pop-up box and follow the directions on-screen. The directions will guide you through re-naming, opening, and running the first program.

d. After you have clicked the green play button to run the code that you see on the screen, continue on to Step 2.



Note for Teachers: Pythonroom has class management features! For instructions, visit our projects page: http://www.2025kids.com/projects

2 Keep Building!

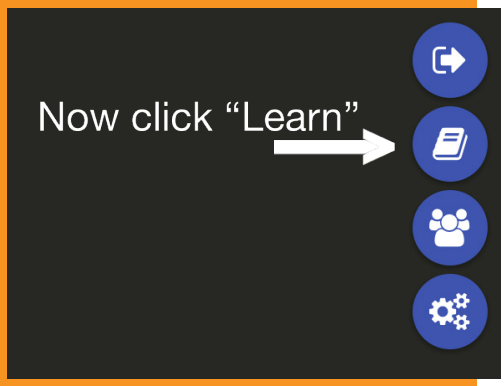
a. Follow the Pythonroom instructions to click on your name at the bottom left hand corner of the screen to go back to your dashboard.

b. You will be asked, “Who are you teaching?”.Unless you are a teacher, pick **Myself**.

c. Teachers can set up a classroom of students, if desired, at this point. Students: follow the on-screen instructions to continue.

3 Keep Learning!

Click on the **learn** button on the right side of your dashboard to access the Python book.



4 Create a MadLibs-like Program

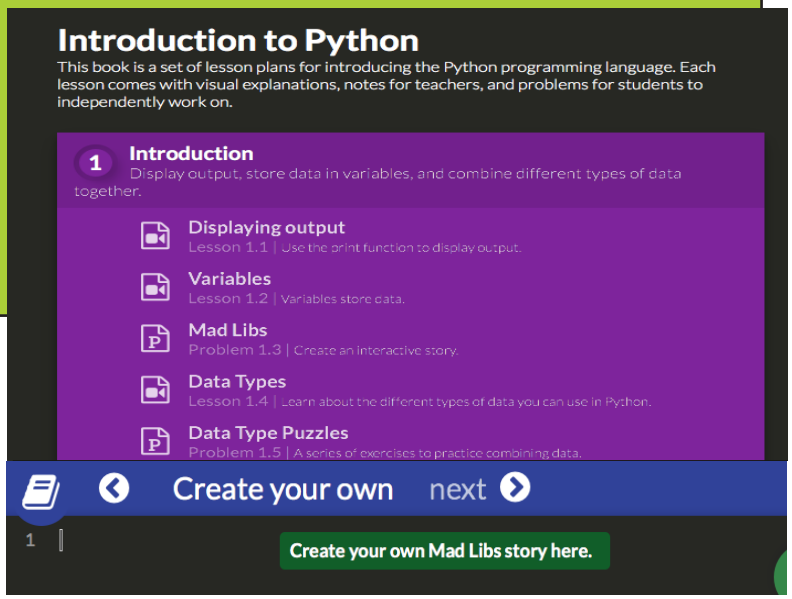
a. Click on the first section of the **Introduction**, **Displaying output**. Go through the entire lesson until you feel comfortable displaying output. It is ok to do the lesson multiple times!

b. Continue onto the second section, **Variables**.

c. Once you complete and understand this section, move to the third section, **Mad Libs**. When you complete this lesson, you will have created your own Mad Libs-like program!

d. Continue creating cool programs in Pythonoom, such as:

- Fibonacci number sequence
- Rock, paper, scissors game
- Choose your own adventure game
- Pig Latin translator
- Secret code generator



Tips and Tricks

Each programming language has a **syntax**. A syntax just means that it has a particular way to write the commands. For example, each language has a different way for you to tell it to put a message box up on the screen.

Word Search

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

computer
network
email
web page
browser
app
router
packet
server
program
internet
http
hack
cybersecurity
password
privacy
bug
online
virus

Test your knowledge!

1. The device that connects different parts of networks together and figures out how to route traffic is called a:

a. web b. router

c. blog d. email

2. When Internet data gets broken into little pieces that are sent independently, those pieces are called:

_ _ _ _ _ _ _ _

3. The early network that led to the development of the Internet was called the:

a. Apple Net

b. HairNet

c. NothingButNet

d. ARPANET

Fill in the blanks!

Making a Video Game

One day we decided to make a video game of our own. In our video game the _____ (game main characters)

try to _____ (what the character tries to do) in order to _____ (goal of the game). We decided to include other

types of characters in the game, like _____ (other characters) and _____ (other characters). We let the

characters use _____ (plural noun) as _____ (plural noun). Our game had _____ (number) levels,

and you could win by _____ (how you win the game). One more interesting thing

about our game was that you could _____ (something else your game could do).

We showed our parents – they were _____ (past tense emotion). My mom said _____ (what your mom might say),

and my dad said _____ (something your dad might say). The next game we build will definitely include

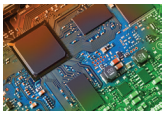
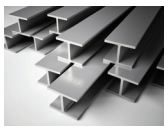
include _____ (plural noun) and _____ (plot twist, special effect, or new feature)!

Illustrate your video game!

It's Material

Solve the Logic Puzzle below to learn about materials inventions



Use the hints to identify which material is which in this logic puzzle.

Hints:

1. Silicon is element number 14 on the Periodic Table of the Elements.
2. Steel is made from Iron (element number 26 on the Periodic Table), with just a little bit of Carbon (element number 6).
3. Adding other ingredients and changing the ratio of ingredients can make different types of Steel. For example Zinc (element #30) could be added to prevent the Steel from rusting.
4. Carbon Fiber is both stronger and stiffer than both Steel and Aluminum, but it is also quite lightweight.
5. Aluminum is the most abundant metal in the earth's crust.
6. Titanium is stronger than Aluminum, but it is also heavier.

Material Description	Material				
	Silicon	Carbon Fiber	Titanium	Aluminum	Steel
1. This material is an element on the Periodic Table of the Elements - it is not a composite material or metal alloy (combination of metals). It is as strong as steel, and twice as strong as aluminum. It is 45 percent lighter than steel; but it is 60 percent heavier than aluminum.					
2. This material is a combination of two materials from the Periodic Table of the Elements (and sometimes has some additional materials added to prevent rust). It is a very strong material, a good heat conductor, but rusts easily unless treated or painted. This material is very commonly used in structures. According to sciencewithkids.com, in 2012 alone, more than 6.4 million tons of this material was used in structures – that is equivalent to more than 40 pounds of it per person in the United States.					
3. This material is an element on the Periodic Table of the Elements. It is known for its electrical conductivity, which is in between good conductors and non-conductors. It can conduct electricity but not easily. It is known for its use in computers, but you likely have seen it as a compound in grains of sand.					
4. This material is a composite material, which means that it is made from multiple materials combined together. It is made from human hair sized strands of carbon, combined with epoxy, and then cured in a mold to make it into a particular shape. It is four times stronger than steel and eight times stronger than aluminum, and stiffer than both of those, and very lightweight for its strength.					
5. This material is an element on the Periodic Table of the Elements. You probably have seen it in things like foil and cans. It is easy to recycle, and it is cheaper to recycle it than to create it. It is the most abundant metal in the earth's crust. The pure form of this element is soft and ductile and not very strong, but it can be made stronger with the addition of other metals. It is a better heat conductor than steel, a good electrical conductor, and does not rust easily.					

Learn more about the Periodic Table of the Elements at web sites like: www.chem4kids.com.

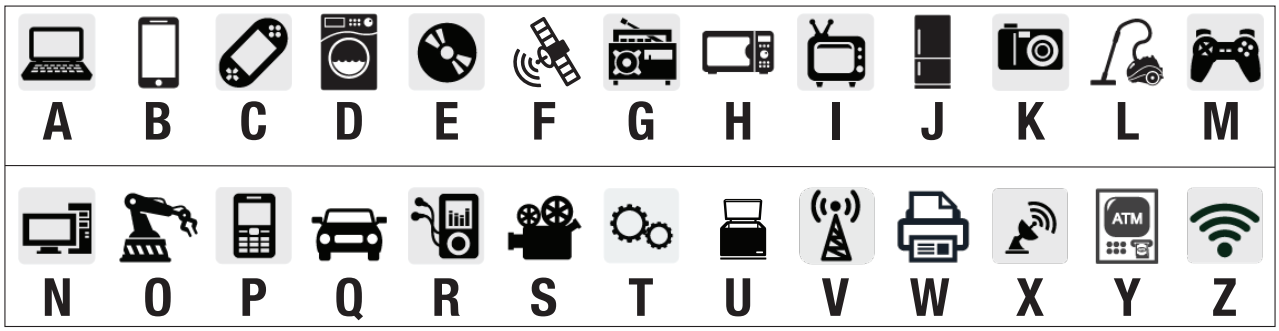
Cipher Time

Codes and Ciphers

Codes and ciphers have been used to send secret messags for a very long time. Julius Caesar used something we call a **Caesar Cipher** to send secret messages to his generals at war. The Caesar Cipher is a **substitution cipher**, where the letters of the alphabet are shifted by some number. For example, if you shift by three letters, then you would write 'A' as 'D', 'B' would become 'E', 'C' would become 'F', and so forth.

A **cipher** is a way to make a message secret by changing the letters in the message. Each letter is replaced by something else - which could be another letter, a number, or an image. A **code** changes the whole word for something into something else.

The puzzle below is a substitution cipher that uses pictures of technology inventions for each letter. See if you can solve the puzzle! It is a famous quote by Albert Einstein.



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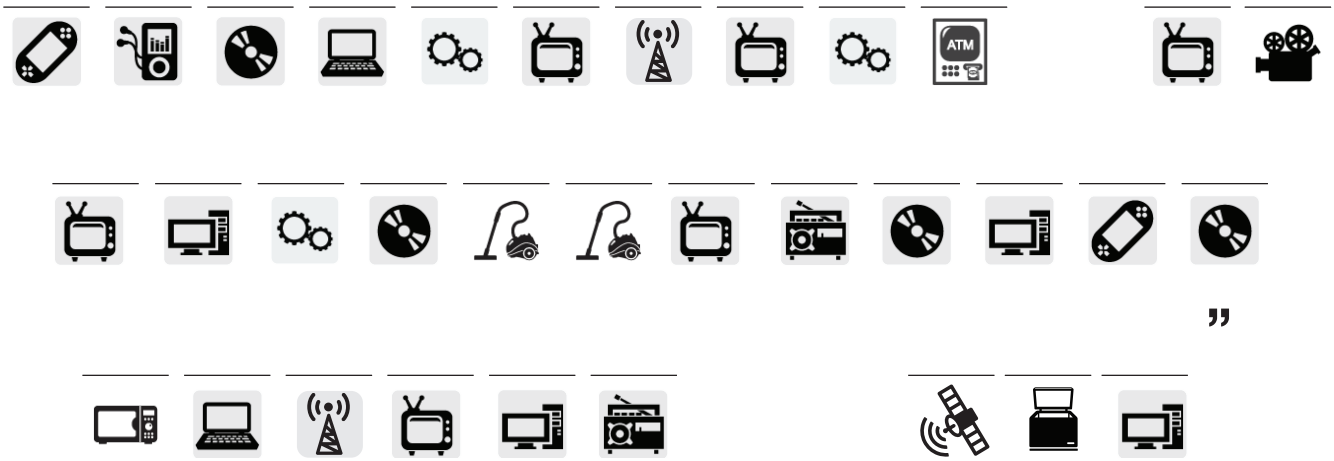
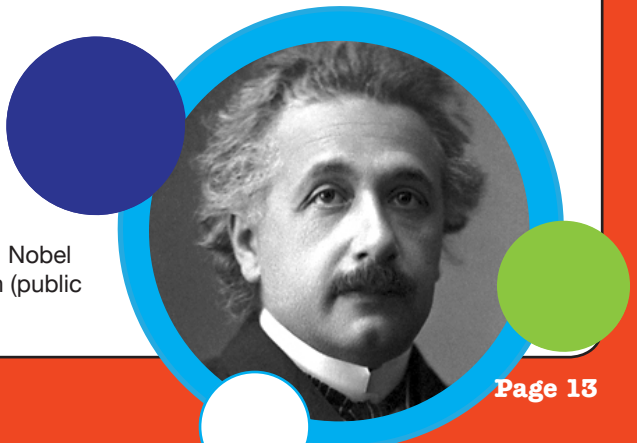


"

*See back for answers



Albert Einstein, official 1921 Nobel Prize in Physics photograph (public domain image)

Meet the Characters!

This issue's Featured Character:

Grasshopper

Meet Grasshopper!

Grasshopper loves to write computer programs and wants to be a programmer when she grows up. Fun Fact: Grasshopper was named after Grace Hopper, the woman who invented the compiler and the concept of high-level programming!

Learn more about our characters at www.2025kids.com/characters

Meet a real engineer!

Engineers are regular people, just like you and me. They love to solve problems and like challenges. Meet this month's featured engineer!

Name: Eron

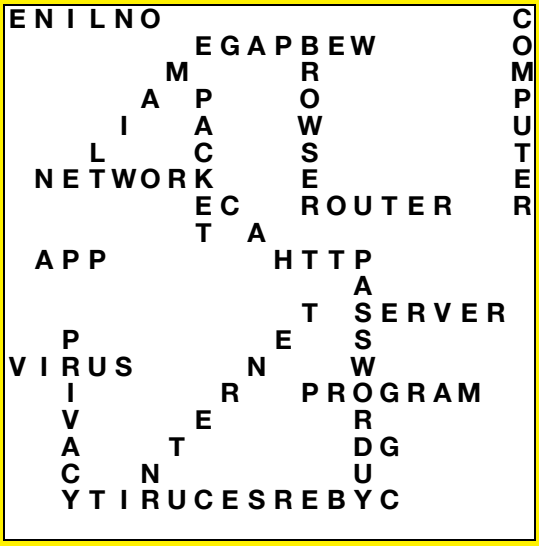
Type of Engineering: Computer Science and Game Design

Engineering Interests: 3D modeling, 2D art, programming, website design, game design

Hobbies: Drawing, playing music, creating video games

Reason He Chose Engineering: From childhood Eron always wanted to create video games. As he grew older he grew to love drawing, writing and music, but was also good at math. When he went off to college he realized that he could do everything he loved studying game design. Now, he enjoys making games and studying computer programming at University of California, Santa Cruz, getting to do all the things he loves.

Answers:



Test your knowledge (page 12): 1.) b. router 2.) packets 3.) d. ARPANET

It's Material (page 14): 1.) Titanium, 2.) Steel, 3.) Silicon, 4.) Carbon Fiber, 5.) Aluminum

Cipher Time (page 15): "Creativity is intelligence having fun." [Albert Einstein]

2025 kids

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About 2025 Labs

We are a services company company with a social mission to bring engineering and technology literacy to all kids and inspire a more diverse next generation of technology creators. Come visit our web site at: www.2025kids.com.