How to make GREAT Ideas for INVENTIONS

A Book for Young Inventors

PROJECT FUNDED by the Korea Funds-in-Trust at the World Intellectual Property Organization

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THEME: CREATIVE PROBLEM SOLVING PROJECT

1. Make a cup stand on its handle! 094p
2. Grab the rolling object! 106p
3. Create a toy out of a discarded CD! 116p

PART 1
UNDERSTANDING INVENTION

The first invention was perhaps made when a caveman attached a grip to his stone axe to give his chops more power.
Can you believe that running water which is now an indispensable part of modern life, first used in 2,300 B.C.? In the past, buttons were not only used for adjusting clothes, they were treated as jewels.
Pizza originated from soldiers using their shields to bake bread, and high heels originally became popular in Europe because they helped women avoid stepping in filth.

From here on,
get ready to learn
what is really meant by
“invention,” how it has
evolved and how it
affects our lives.

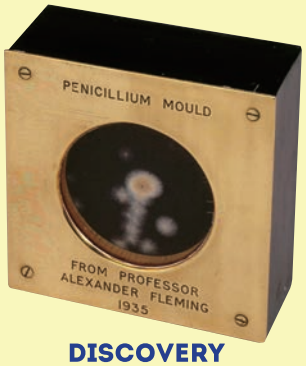
INVENTION AND DISCOVERY

THE DIFFERENCE BETWEEN INVENTION AND DISCOVERY

Let's find out the difference!

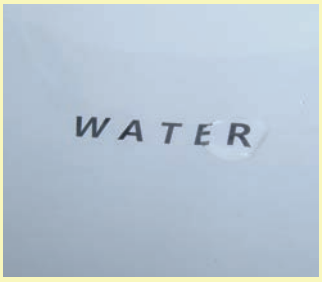
INVENTION MEANS TO create a new object or method that didn't previously exist. It is a combination of the Latin term "invention" (remind of) and the German term "Erfindung" (discover). Confusion often arises between the two, but, unlike a discovery, an invention is the result of an innovative creation.

THEN WHAT IS DISCOVERY? Discovery is defined as the act of detecting new facts about nature. It can be regarded as the stage prior to invention. Many great inventions that significantly impacted humanity were the result of new discoveries in natural phenomena.



DISCOVERY
Blue mold kills bacteria

INVENTION
Penicillin



DISCOVERY
The letter is magnified by the water drop on the surface of the glass

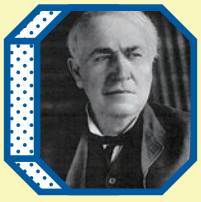
INVENTION
Magnifier (Lens)

Tell others your ideas regarding the difference between discovery and invention.

INVENTION THROUGH DISCOVERY

INVENTION AND DISCOVERY

Connect the invention with the discovery that made it possible. (Use Supplement 01)

DISCOVERY	INVENTION	INVENTOR
An object appears closer when seen through a pair of lenses.		Hans Lippershey (1608)
A photograph becomes highly polished thanks to mercury gas from a broken mercury thermometer.		Louis Daguerre (1837)
It was discovered by Meucci's experiment that a small copper cable connecting two men's mouths enabled them to feel electricity.		Antonio Meucci (1854)
When nitroglycerin is incorporated into a rock known as diatomite, it becomes stabilized and safer to handle.		Alfred Nobel (1866)
This was discovered when Spencer, while standing in front of an active radar set, noticed that the candy bar in his pocket had melted.		Percy Spencer (1945)
Edison realized that the sticky tar on ashtrays cannot be easily removed.		 Thomas Edison (1879)

THE BIRTH OF INVENTION

10 GREATEST INVENTIONS IN HISTORY

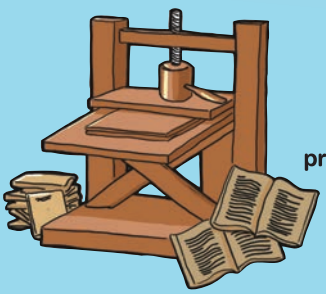
These are the top 10 greatest inventions, as chosen by the Wall Street Journal in 1999. Let's think about how these inventions affect our lives.

Which invention do you think is the best? Why?

A.D. 1,000

1,086 — **Compass (China)**
It enabled mariners to safely navigate the oceans, thereby increasing sea trade and contributing to the Age of Discovery.

Gunpowder (China) — 1,250

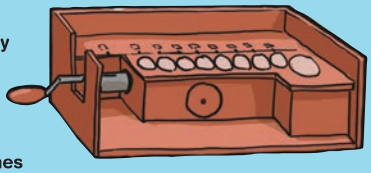


1,329 — **Movable metal type (Korea)**
This enhanced the mass production of diverse types of books, making them more affordable. As a result, more people began to read as the public's thirst for knowledge increased.

The printing press (Germany) — 1,450

Bagel (Poland) — 1,610

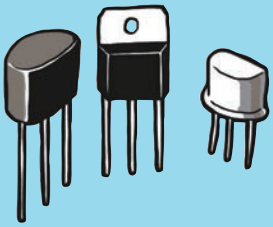
The mechanical calculator (Germany)
Initially, calculators could only perform basic operations, but technological advances eventually enabled them to be further developed into electronic calculating machines (computers).



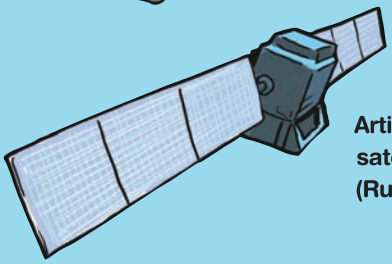
1,671

Light bulb (USA) — 1,879

Transistor (USA)
Its small size and weight, allowed for the later development of miniaturized electronic devices.



1,947



Artificial satellite (Russia) — 1,957

Dolly the cloned sheep (U.K.)
Biotechnology became useful in treating diseases.

1,997

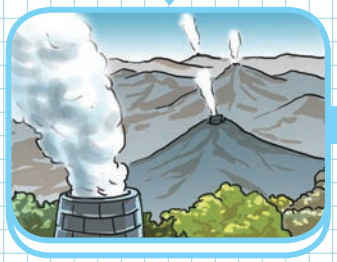
INVENTIONS

THE BIRTH OF INVENTION

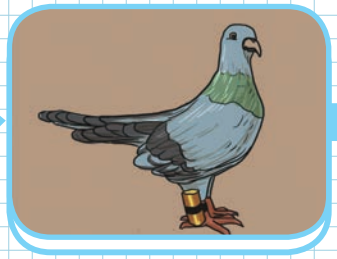
Reflect on the birth of various inventions and their gradual development.

THE BIRTH AND DEVELOPMENT OF COMMUNICATION TECHNOLOGY

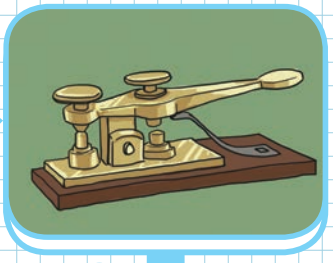
01 Letters delivered on foot



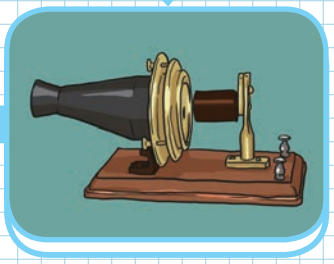
02 Smoke Signals



03 Homing Pigeon



04 Morse Code



05 Telephone invented by Alexander Bell

06 Telephones

07 Portable phones

08 Smartphones

"Necessity is the mother of invention."

Human beings have survived by creating the things they desperately need. Discovery and invention enable human civilization to develop and populations to flourish. Through them, we discovered fire (which keeps us safe and warm), created simple tools made from rocks, and so on.

Discoveries, inventions, new methods and concepts – their common trait is that they were **"first."**
Each is an attempt to achieve or express something that no one ever thought of before. They can sometimes result in revolutions in how we live our lives.

THE BIRTH OF INVENTION

DEVELOPMENT OF INVENTIONS

The following illustrations show us the developmental processes of three different inventions. How might they continue to evolve in the future?, Draw or write out your ideas in the "FUTURE" column.

PAST	PRESENT	FUTURE

THE IMPORTANCE OF PATENT APPLICATIONS

THE VALUE OF INVENTION

Study the importance of patent applications through specific cases.

TAKE A LOOK AT THE VARIOUS CATEGORIES OF INTELLECTUAL PROPERTY RIGHTS.

THE SAFEGUARDING OF INTELLECTUAL PROPERTY RIGHTS AND INVENTORS.

Intellectual property rights are the exclusive rights given to persons over their creations. These rights encourage human creativity. In particular, patents encourage more inventions so that further development might be achieved.

ABRAHAM LINCOLN : "The patent system is the fuel of interest to the fire of a genius in the process of discovery and production of new and useful things."

A patent is the inventor's exclusive rights to his invention. Once a patent is granted, other people cannot use the invention without the inventor's permission. Patents make people realize the value of an invention, and guarantee the inventor his or her deserved profit.

• CASE • **The telephones of Antonio Meucci, Alexander Graham Bell, and Elisha Gray**

Antonio Meucci, who came up with the idea for the telephone five years before Bell did, was too broke to apply for a patent. Elisha Gray applied for a patent, but she did so two hours after Bell. Alexander Graham Bell's patent ensured his place in history as the inventor of the telephone.

FIND THE INTELLECTUAL PROPERTY RIGHTS FOR A MOBILE PHONE.

1. ( )
   Overall shape, speaker shape, button shape, etc.
2. ( )
   Model name, manufacturer's name, etc.
3. ( )
   Wireless internet system, electronic signal conversion system, wireless communication, etc.
4. ( )
   downloaded music, books, etc.

THE VALUE OF INVENTION

SOCIAL CONTRIBUTIONS OF INVENTORS

Inventors and their contributions to society.

LINUX, A RIVAL TO MS WINDOWS

Linux, an operation system for personal computers, is open software distributed free of charge, and its source code (blueprint) has been made available to the public. Linus B. Torvalds, a Finnish undergraduate, created Linux by modifying an OS for large computers into one that could be used for personal computers. With the expansion of the Free Software Campaign, promoting no-limits usagee, copying, and modification of computer software , Linux has become increasingly popular to the point that it is now a strong rival to Microsoft's MS-Windows. How do you think the world might be different today if the World Wide Web were patented by its inventor, Tim Berners-Lee?

IF?

WHAT DO YOU THINK THE WORLD MIGHT BE LIKE TODAY IF THE INVENTOR OF THE WORLD WIDE WEB, TIM BERNERS-LEE?

Since November 1991, when Linux was opened to the general public via the Internet, thousands of developers all over the world have voluntarily contributed to its further development.
As Linux became popular, various Linux-based, open-sourced OSs were developed. Android, an open-sourced OS for mobile devices distributed by Google, is based on Linux. In this manner, Linux has had a great impact on the development of various computer operation systems.

TIM BERNERS-LEE, WHO DIDN'T PATENT THE INTERNET, ALLOWED OTHERS TO USE IT.

In 1989, the WWW (world-wide web) was first proposed by Tim Berners-Lee as a more effective CERN (The European Organization for Nuclear Research) communication system. It allowed computers to be inter-connected like a web, granting users easy access to all available information in the network. This innovation led to the development of the Internet as we know it today.

How would modern society be different if Linus B. Torvalds, creator of Linux, and Tim Berners-Lee, inventor of the WWW, had not freely shared their inventions with the general public?

DISCOVER A NEW INVENTION

THINK ABOUT IT

The following are negative reactions toward inventions. Tactfully express your thoughts on these statements.

There is no reason for any individual to have a computer in his/her home.

Kenneth Olsen
the co-founder and CEO of Digital Equipment Corporation in 1977

Perhaps

we would still live in a modern primitive society and all be bookworms because information and records would be stored solely on paper.

A man-made trip to the moon will never occur regardless of all future advances.

Dr. Lee de Forest
the inventor of the Audion tube and the father of radio in 1967

What?

Television won't be able to hold on to any market it captures after the first six months. People will soon get tired of staring at a plywood box every night.

Darryl Zanuck
executive and movie producer at 20th Century Fox, 1946

Why?

Airplanes are interesting toys, but of no military value.

Ferdinand Foch
a French commander and military theorist during World War I in 1911

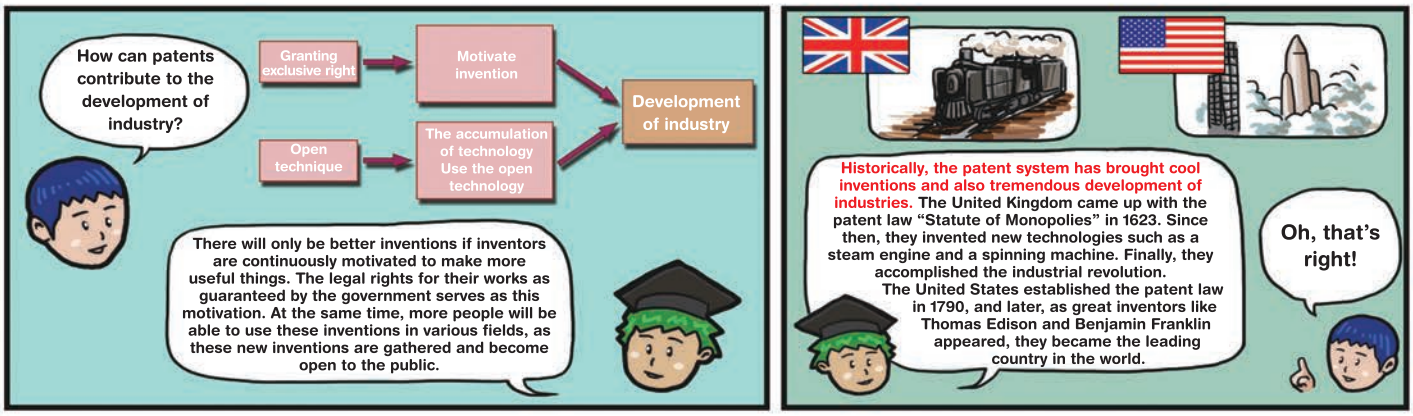
No,

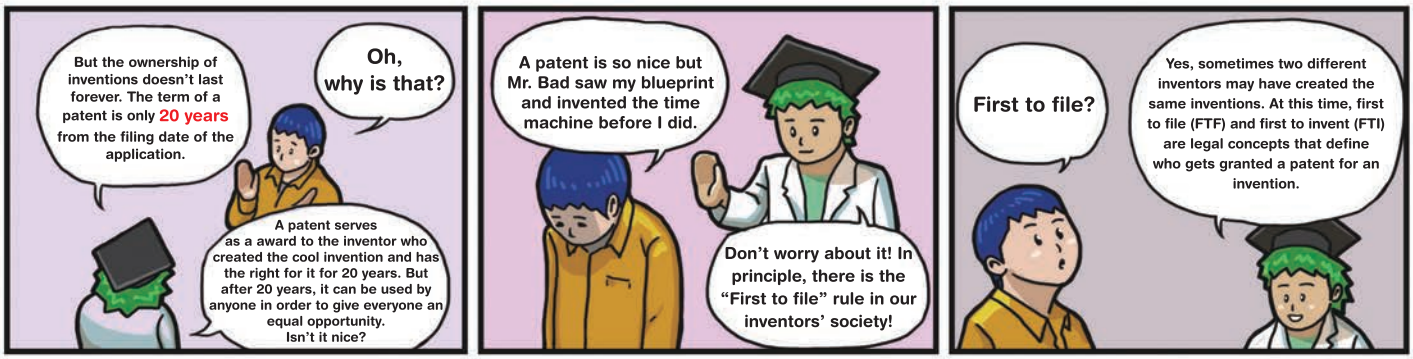
Everything that can be invented has been invented.

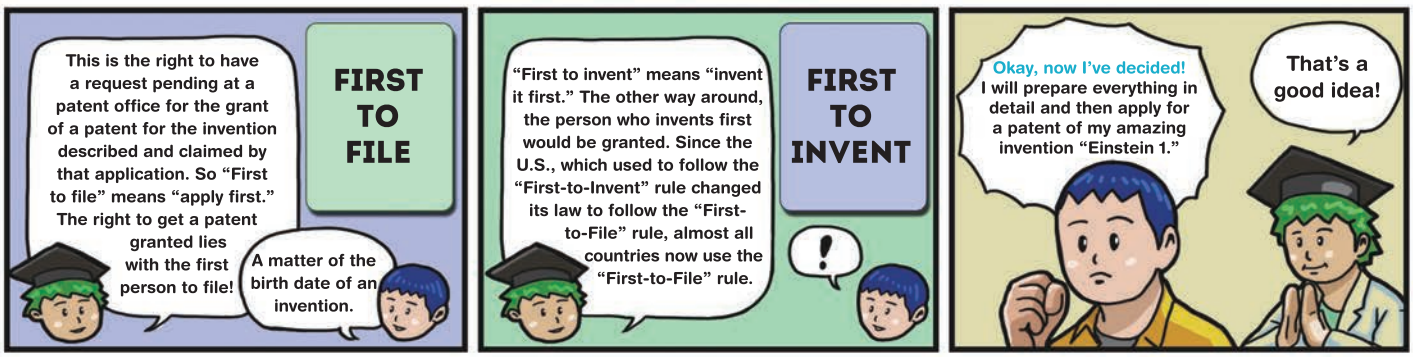
Charles Duell
Commissioner of the USPTO in 1899

I don't think so because

A PATENT IS AN INVENTOR'S B.F.F.


How can patents contribute to the development of industry?
Granting exclusive right
Motivate invention
Open technique
The accumulation of technology Use the open technology
Development of industry
There will only be better inventions if inventors are continuously motivated to make more useful things. The legal rights for their works as guaranteed by the government serves as this motivation. At the same time, more people will be able to use these inventions in various fields, as these new inventions are gathered and become open to the public.
Historically, the patent system has brought cool inventions and also tremendous development of industries. The United Kingdom came up with the patent law "Statute of Monopolies" in 1623. Since then, they invented new technologies such as a steam engine and a spinning machine. Finally, they accomplished the industrial revolution.
The United States established the patent law in 1790, and later, as great inventors like Thomas Edison and Benjamin Franklin appeared, they became the leading country in the world.
Oh, that's right!


But the ownership of inventions doesn't last forever. The term of a patent is only 20 years from the filing date of the application.
Oh, why is that?
A patent serves as a award to the inventor who created the cool invention and has the right for it for 20 years. But after 20 years, it can be used by anyone in order to give everyone an equal opportunity. Isn't it nice?
A patent is so nice but Mr. Bad saw my blueprint and invented the time machine before I did.
Don't worry about it! In principle, there is the "First to file" rule in our inventors' society!
First to file?
Yes, sometimes two different inventors may have created the same inventions. At this time, first to file (FTF) and first to invent (FTI) are legal concepts that define who gets granted a patent for an invention.


FIRST TO FILE
This is the right to have a request pending at a patent office for the grant of a patent for the invention described and claimed by that application. So "First to file" means "apply first." The right to get a patent granted lies with the first person to file!
A matter of the birth date of an invention.
FIRST TO INVENT
"First to invent" means "invent it first." The other way around, the person who invents first would be granted. Since the U.S., which used to follow the "First-to-Invent" rule changed its law to follow the "First-to-File" rule, almost all countries now use the "First-to-File" rule.
!
Okay, now I've decided! I will prepare everything in detail and then apply for a patent of my amazing invention "Einstein 1."
That's a good idea!

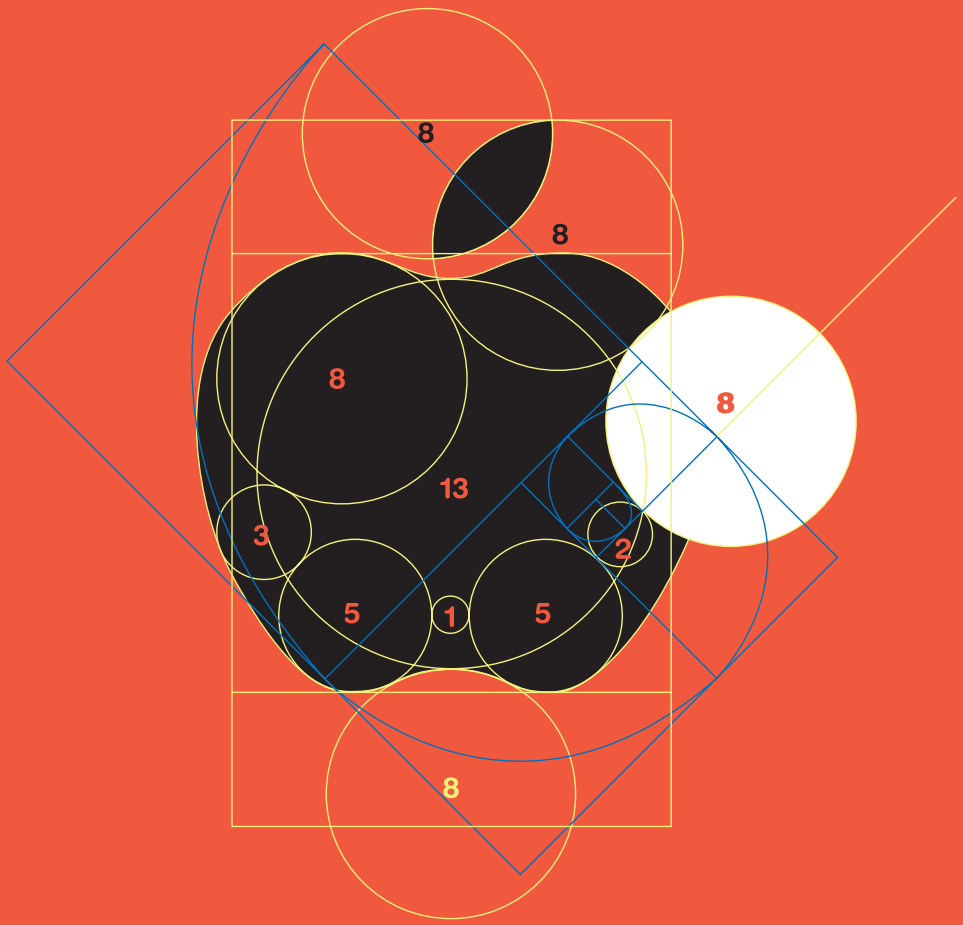
Mr. Good becomes the patentee of "Einstein 1"
Argh...I almost made it!! How did I not know that patents existed?!
It's all because of the patent!

PART 2
CREATIVE THINKING METHODS

Apple's law of 10:3:1

Whenever Apple Inc. designs a new product, the law of 10:3:1 is applied. First, designers create 10 models. Each of the 10 models is based on an entirely different concept for the completed product, then 3 of the models are selected and modified for an additional 3 months. The final design is determined from those 3 models.

10 : freely design 10 models, using the method of divergent thinking
3 : analyze the 10 completed models, using, convergent thinking, then select 3
1: after further modifications and additions, select the final one



Now, you will learn 2 methods of critical thinking to help you come up with new ideas more easily.

DIVERGENT AND CONVERGENT THINKING

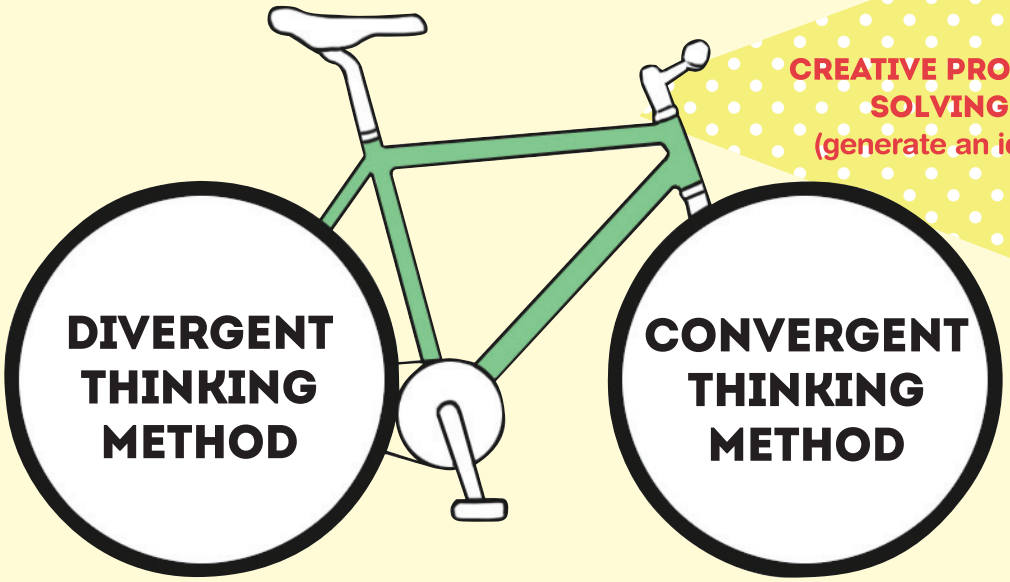
SHORTCUT TO CREATIVE PROBLEM SOLVING

Learn the methods of divergent and convergent thinking.

THE METHOD OF DIVERGENT THINKING is to come up with many new and, unique ideas (possibilities and alternatives) in various ways through a diverse point of view. Different types of divergent thinking include brainstorming, SCAMPER, and so on.

THE METHOD OF CONVERGENT THINKING is to effectively select and develop the best idea through a process of examination, comparison, and classification. Different types of convergent thinking include the Plus/Minus/Interesting (PMI) strategy, evaluation of the matrix method, and so on.

To engage in creative problem-solving, come up with new ideas through the divergent thinking method, then select the best ideas through the convergent thinking method. Finally, take the time to modify and refine your idea.



CREATION OF A NEW BUS

FURTHER INFORMATION

Make a new bus using the divergent and convergent thinking methods.

YOU WANT TO BE ABLE TO HAVE AS MANY PASSENGERS AS POSSIBLE ON THE BUS.

Make a new bus utilizing the brainstorming and PMI methods.

Divergent
Brainstorming

THE CREATION OF A NEW BUS

Convergent
PMI Method

Stage 1

Expand the idea through brainstorming

What is Brainstorming?

brain + storming = brainstorming

Freely and uncritically come up with as many new ideas as you can, then improve and develop them.

Rules of brainstorming

No criticism
Don't worry about negatives.

Carefree
Think and discuss it freely.

Rack Your Brain
The quantity of ideas is more important than the quality.

Combine / Improve
Combine, utilize, and improve the ideas.

Let's try brainstorming designs for a new bus!

01 eliminate seats on the bus

02

03

04

05

06

07

08

FURTHER INFORMATION

CREATION OF A NEW BUS

Stage 2

Collect ideas using the PMI method (Plus · Minus · Interesting)

What is the PMI method (Plus · Minus · Interesting)?

This method helps keep you open-minded when considering an idea or proposal. Decisions are made after considering all possibilities, including the positive, negative, and interesting aspects of the idea.

PMI process

01	02	03	04	05
Identify the idea (alternative)	Find good points related to the idea	Find bad points related to the idea	Find interesting points related to the idea	Identify the best idea regarding its good and bad points

Selected idea 1 – eliminating seats on the bus

PLUS
pros, affirmation

P More passengers can get on it.
The open spaces can be used in various ways.

MINUS
cons, denial

M When the bus suddenly stops, passengers might fall down.
There would need to be many handles hanging from the ceiling.

INTERESTING
amusing

I It would be fun to change or reorganize the positions of some of the seats.

If we eliminate a few sections and change the seat positions, people would have more standing room.

Stage 3 – Design a new bus

Apply the PMI Method

Choose other brainstormed ideas, and apply the PMI method to design a new bus.

Selected Idea –

P

M

I

Selected Idea –

P

M

I

FURTHER INFORMATION

THE TRANSFORMATION OF THE PRINTER

Utilize divergent and convergent thinking to design a new printer.

You wish to make a new printer. Design one through the SCAMPER and evaluation of matrix methods.

Divergent SCAMPER method → **THE TRANSFORMATION OF THE PRINTER** ← **Convergent** Evaluation of matrix method

What is the SCAMPER method?

SCAMPER is a checklist composed by Bob Eberle in 1971. It was constructed to look like a game, and the acronym represents 7 different inventive stages. This checklist aids us in assemblinge ideas and usinge our imagination.

EXAMPLES OF THE SCAMPER METHOD

ADAPT
Can it be adjusted according to various conditions and purposes?

! It can print on various materials (i.e., photographic paper, fabric, stickers, etc.) depending on its purpose and usage

COMBINE
What can be combined?

! A copier, scanner, fax machine, etc. are combined in a multi-functional printer

SUBSTITUTE
What can be substituted?

! Instead of liquid ink, special powder is used as toner in laser printers.

ELIMINATE
What can be deleted and reduced?

! A wireless printer

MODIFY, MAGNIFY, MINIMIZE
How can its features or shape be changed, reduced, or enlarged?

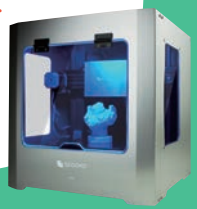
! portable printer for smart phones

REARRANGE
Can its shape or form be changed?

! Insert more paper into the lower drawer, build a back drawer so it doesn't flip over.

PUT TO OTHER USES
Could it be used for other purposes?

! A 3D printer that can actually make an object.



Stage 1

Expand the idea using the SCAMPER method

COMBINE

ADAPT

SUBSTITUTE

EXPAND IDEAS FOR A NEW BICYCLE USING THE SCAMPER METHOD

REARRANGE

MODIFY, MAGNIFY, MINIFY

PUT TO OTHER USES

ELIMINATE

FURTHER INFORMATION

TRANSFORMING A BICYCLE

Stage 2

Collect ideas using the paired comparison analysis method

What is the paired comparison analysis method?

A systematic evaluation method that grades proposed ideas according to pre-determined standards

With this in mind, make an evaluation table with the ideas to be evaluated located along the vertical axis. Place the pre-determined standards on the horizontal axis. Then evaluate the ideas according to each standard.

Using the SCAMPER method to construct, an evaluation table.

1. Fill out the SCAMPER acronym along the vertical column.
2. On the horizontal column write the standards of evaluation applicable to each new idea for the bicycle.
3. Evaluate the ideas based on the standards of evaluation, then decide on the best one.

idea	Aesthetics (20)	Economic (20)	Safety (20)	Ease (20)	Expertise (20)	Total (100)
S						
C						
A						
M						
P						
E						
R						

Final idea

Stage 3

EXPRESS THE SELECTED IDEA IN DETAIL.

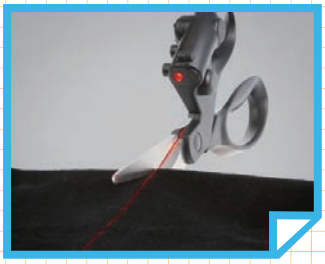
UTILIZING METHODS OF PROBLEM SOLVING

THINK ABOUT IT

Utilize the divergent and convergent thinking methods to fashion a new kind of scissors.

PRACTICAL EXERCISE : The following are scissors designed for enhanced convenience in certain situations. They have been modified from typical scissors, and can be used at home or at school. Utilize the divergent and convergent thinking methods to come up with a new style of scissors that would be especially convenient in a particular situation.

Scissors used to cut paper, fabric, etc. into fine pieces.



Laser scissors used to cut straight lines with the help of a laser beam.

Standing kitchen scissors used for preparing food without touching other surfaces.

Scissors used to cut and serve pizza more easily.

stage 1

To come up with more ideas, decide as a team which divergent thinking method to use, then give it a try.

stage 2

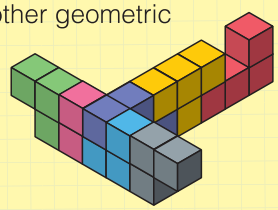
Select three good ideas and evaluate them via a convergent thinking method.

FINAL IDEA

SOMA CUBE, AN INVENTION THAT FOSTERS CREATIVITY

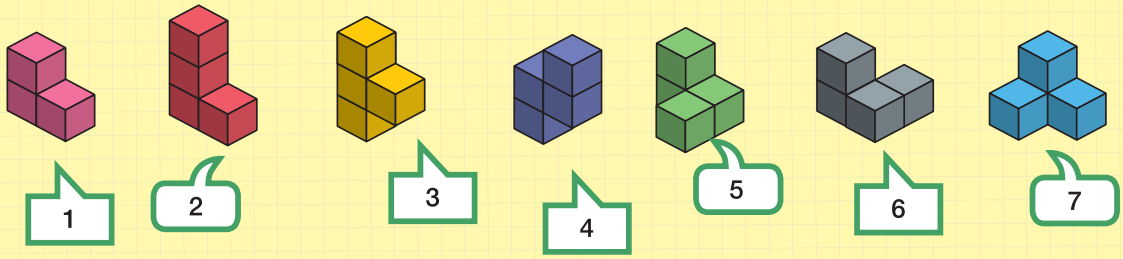
TAKE A LOOK AT THE SOMA CUBE

The Soma Cube is a highly addictive toy. It is a three-dimensional puzzle consisting of 7 little pieces. Each piece is formed from 3 or 4 tiny cubes. By assembling these pieces together, we can form a much larger cube in more than a hundred different ways, as well as thousands of other geometric shapes.



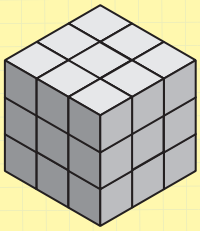
PREPARE THE SOMA CUBE

Using the planar figure, make 7 Soma Cube pieces. (Use Supplement 02)

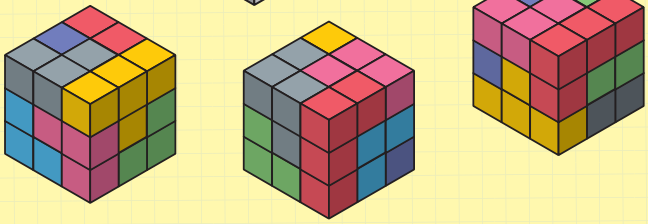


PLAY WITH THE SOMA CUBE

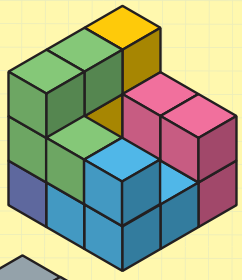
1. MAKE A CUBE:
Use the little pieces you made to form, a large cube.



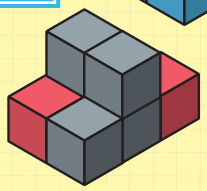
2. OTHER APPROACHES:
Compare how you and your friends made your cubes, then think of even more ways to construct them. There are a total of 240 ways to make a large cube using these 7 pieces.

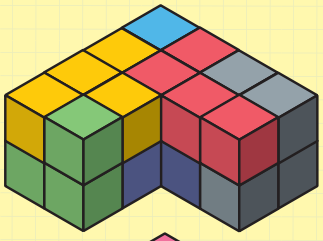


3. CREATING VARIOUS SHAPES:
Models constructed from the pieces



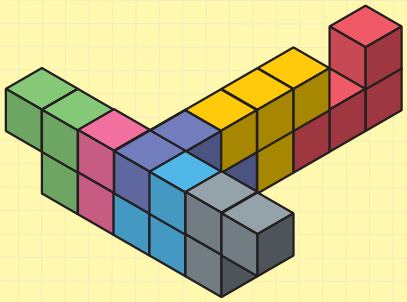
Soma pair1

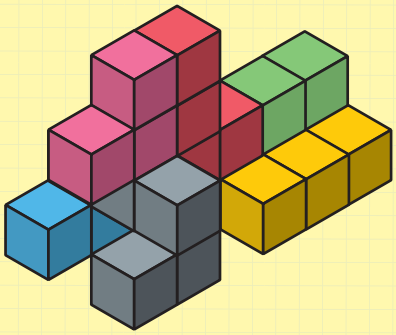




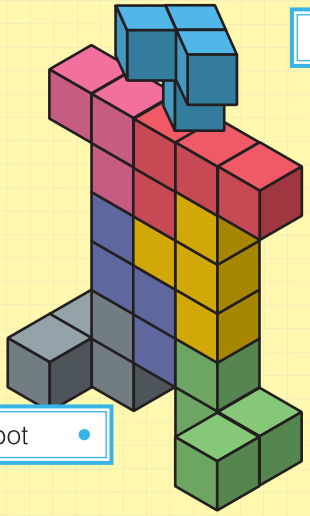
Soma pair2

The Airplane



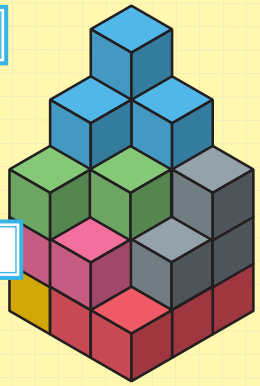


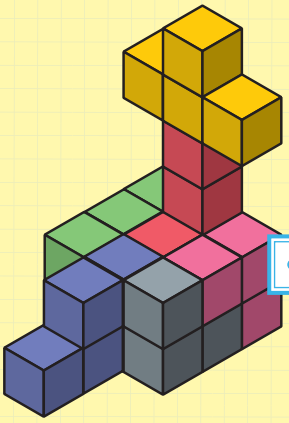
The Dog



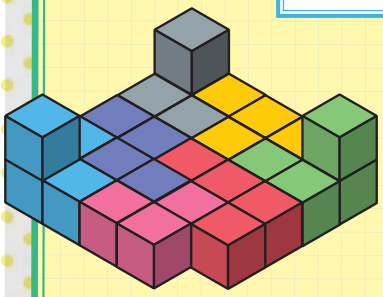
The Robot

The Crystal

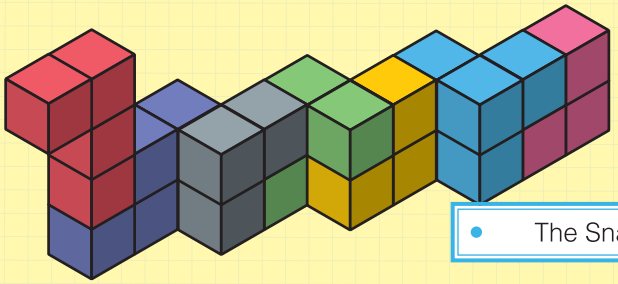




The Tomb



The Castle



The Snake

PART 3
METHODS OF INVENTION

What if we put clothes on a house?

These advertisements show houses wearing warm winter clothing. Are these houses indeed warm?
A famous boiler company in Italy wanted people to know at first glance that these house were warm. After considering what they could do to the houses to give people the impression of warmth, they finally decided to give the houses coats. The advertisements were a huge success.

Can you think of other ways to advertise a boiler company? How can you give people the quick impression that a particular house is nice and cool?

Now, we will explore 10 methods of invention. You will see that coming up with new ideas is simple and easy.

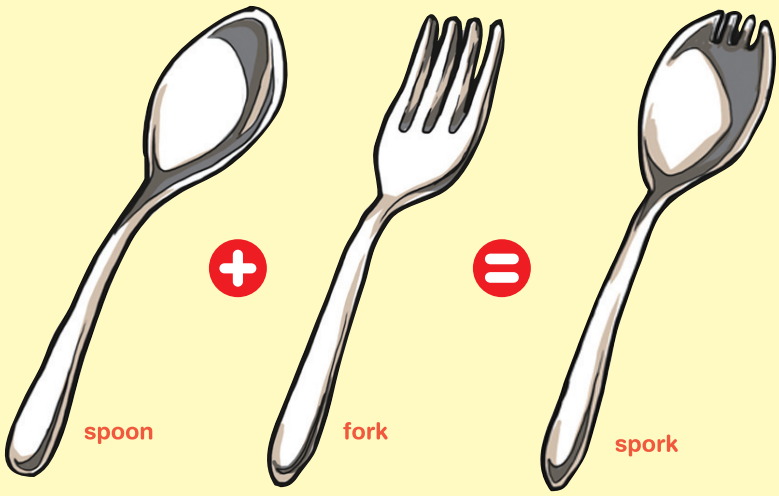
TECHNIQUES TO COME UP WITH IDEAS

10 METHODS OF INVENTION

Let's learn the 10 methods of invention!

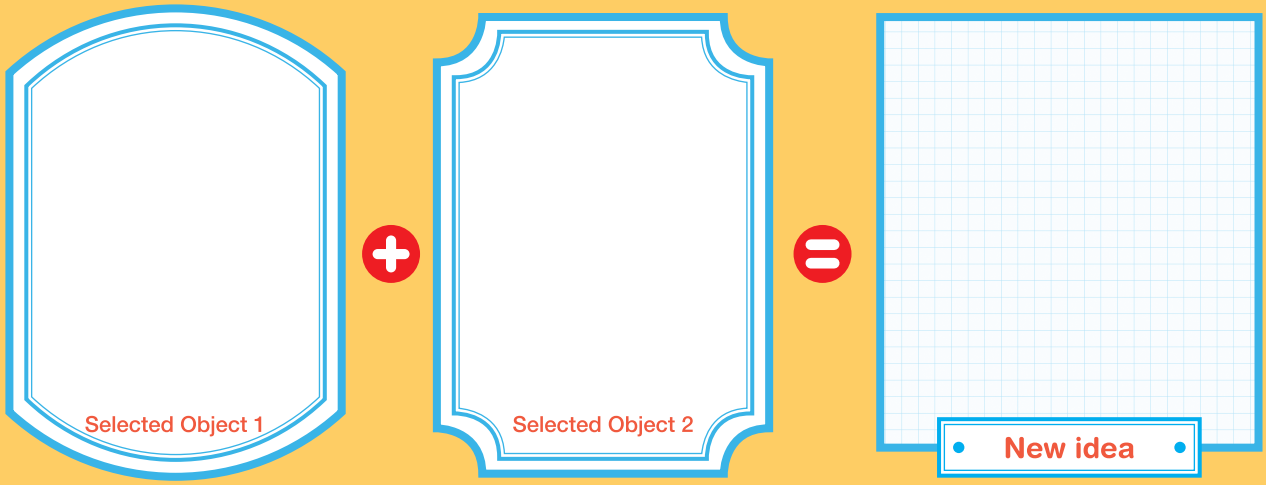
01 Inventing through combination

Combining multiple products or ideas is an easy way to create a more convenient invention. This is the most frequently used method for invention, so a lot of famous items were based on it.



A METHOD OF INVENTION is a way to help people come up with ideas for creating inventions by fixing fla ws and inconveniences inherent in existing products. Many inventors have suggested different methods of invention. Among these, addition, subtraction, sizing, borrowing ideas, shaping, alteration of use, reverse, changing materials, recycling, and imitating nature are the most popular.

Come up with a new invention by choosing two objects from among the following products and combining their function or shapes. (Use Supplement 01)



02 Inventing through removal

Many products are even better and more convenient when certain parts are removed.
Legless chairs are a good example.

camera

film

Digital camera
without film

Come up with a new invention by choosing one object from among the following products and by getting rid of its function or shape. (Use Supplement 01)

Selected Object 1

Removed function
or shape

New idea

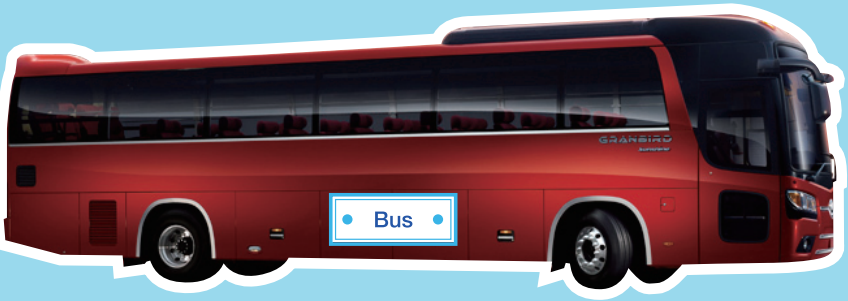
03 Inventing through maximization/ minimization

Would a particular item be more convenient if it were a little bigger? How about a little smaller? Making small objects bigger, or vice-versa, is one method of invention.

Bicycle

smaller

Folding bicycle



Bus

bigger

Car

Come up with a new invention by choosing an object among the following products and altering its size, weight, length, or thickness. (Use Supplement 01)

Selected Object 1

Sizing

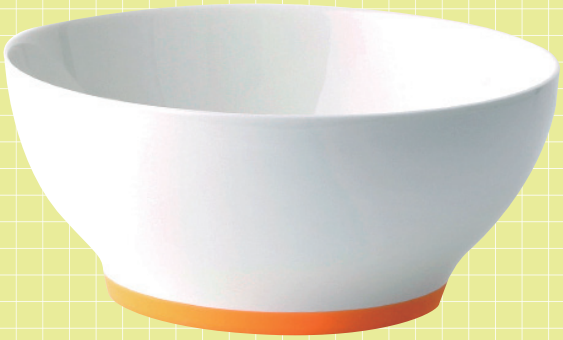
New idea

04 Inventing through adaptation

A successful invention can be the result of a borrowed idea, an addition to a previous idea, or a change in the way something is used. One example is a mosquito net that resembles a tent.

▶Non-slippery gloves

▶Non-slippery bowl



▶Tent

▶Mosquito tent

Come up with a new invention by choosing two objects from which to improve and borrow ideas. (Use Supplement 01)

Object to Improve

Borrowed Idea

New idea

05 Inventing through modification

Making existing products more convenient by altering their shape is also a good method of invention. The change in shape is primarily for convenience, but we must also consider the importance of making a product with an appealing design.

▶Toilet paper embossed with a vine pattern

▶Toilet paper

▶Tissue box

Come up with a new invention by choosing an object from among the following products and improving it by changing its shape. (Use Supplement 01)

Object to Improve

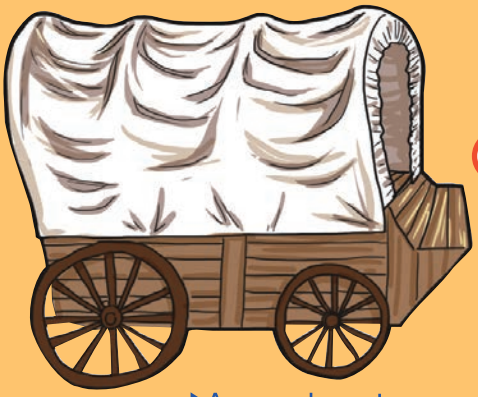
Shape to change

new idea

06 Inventing through alternate usage

Most products were invented with specific uses in mind. However, we can determine new uses for products when we look at them from a different perspective.

MAKE STRONG PANTS WITH THE THICK FABRIC USED FOR OLD WAGON BONNETS



▶A wagon bonnet

▶Jeans

MAKE A WATERING CAN THAT WORKS LIKE KETTLE

▶Kettle

▶Watering can

Come up with a new invention by choosing an object from among the following products and thinking of how it might be used apart from its intended purpose. (Use Supplement 01)

Object to Improve

Different Use

New idea

07 Inventing through inversion

Sometimes, you can create a new invention by examining the size, shape, direction, or characteristics of a product and considering these aspects in reverse. The idea for mittens (boxing gloves) came from socks, and the idea for toe socks came from gloves.

VACUUM

A motorized propeller for blowing air became a vacuum cleaner that sucks up dirt.

TOE SOCKS

Gloves became toe socks that can help prevent athlete's foot.

Come up with a new invention by choosing a product from among the following objects and improving on it by reversing its shape, size, direction, or characteristics. (Use Supplement 01)

Product to Improve

−

Reversed Product

=

new idea

08 Inventing through substitution of materials

Changing the material make up of a product is another way to invent.
By replacing glass bottles with PET bottles or paper cartons, containers became lighter and less likely to break.

▶Glass bottles

▶PET bottles

Come up with a new invention by choosing a product from among the following objects and changing the materials used to manufacture it. (Use Supplement 01)

Product to Improve

Materials to Use

new idea

09 Inventing through recycling

Although it is possible to invent something completely from scratch, you might be better off adapting a previous invention by applying it to a different use, while still maintaining its original shape and function. This is because we need to consider the environment and how to recycle our resources.

ASPHALT is made from oil production residue, and the colorful **SIDEWALK BLOCKS** in the picture were made from old tires.

Come up with a new invention made from common waste products. (Use Supplement 01)

Waste Product

New Purpose

new idea

10 Imitating Nature

All animals and plants have survival features that are uniquely suited to them. Many important inventions were created by imitating their appearances or characteristics. For example, the design of submarines is an imitation of air bladders and the streamlined shape of fish, while barbed wire imitates the thorns found on the stems of roses.

SCUBA FINS
From ducks' feet

HELICOPTER
From the outstretched wings of dragonflies

Match the characteristics or shapes of natural objects to the related inventions.

Octopus suckers

Bee stingers

Dandelion spores

Parachutes

Injection needles

Suction plates

Use the 10 methods of invention to design new sneakers that can make our lives easier and more convenient.

• Classic sneakers •

• Slip-on sneakers •

11TH METHOD OF INVENTION

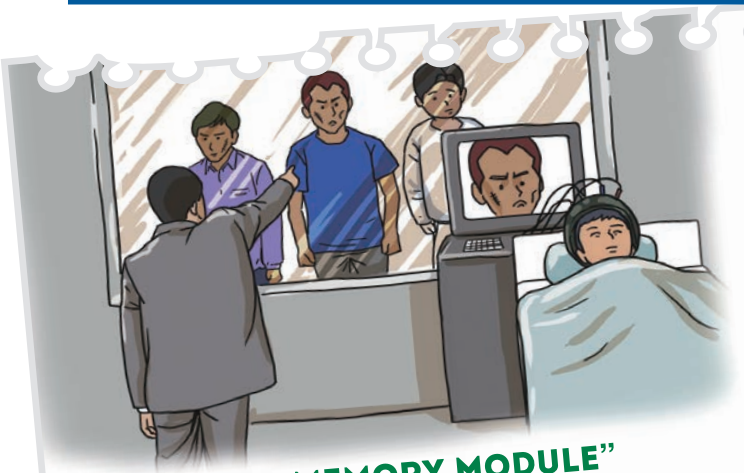
THINK ABOUT IT

Think of an additional method to the 10 methods of invention.

THINK OF AN 11TH METHOD

PRESENT YOUR 11TH METHOD

22ND CENTURY INVENTION NEWS



"COMPLETE MEMORY MODULE" BRAIN IMPLANT IS INVENTED

Saving tremendous amounts of knowledge stored in people's brains

Serial Thief Arrested Thanks to "Memory Deliver" Technology Criminals from the extracted memories of suspects Controversial due to possible infringement of personal freedom and privacy. We enjoy convenient lives by virtue of the development of civilization and technology, but now there are so many more things to learn and remember. What will it be like in the future, when we will have more inventions and newer technology? We will have to acquire more knowledge in order to survive. But don't worry! In the future, various devices will help us remember things more easily. One of those devices will be the "Complete Memory Module," which will prevent you from ever forgetting anything.

SERIAL THIEF IS NOW ARRESTED THANKS TO "MEMORY DELIVER" TECHNOLOGY'

Find the real criminal from extracted memories of suspects Still controversial due to infringement of personal freedom and privacy

What if we could look into the memories of suspects after a crime is committed? It would be easier to catch criminals, and there would be no more innocent people falsely accused. Moreover, even without any real evidence or witnesses, criminals could still be caught and punished. Eventually, the world would have less crime and be a safer place to live. However, this technology has the potential to be abused and infringe upon people's privacy and personal freedom.

New Technology Today

Essential Technology for U.F.O.'s

GRAVITY REGULATOR

Imagine a flying U.F.O. Why doesn't it shoot out flames like a rocket? How can it fly so noiselessly, and what allows it to stop on a dime?
All this is made possible thanks to anti-gravity technology, which allows us to control gravity as we see fit. This technology has been the dream of many scientists, and it has been featured in many American sci-fi novels from the 1900s. So far, however, development has merely reached the stage of maglev trains, which harness the power of magnetic forces.

Compression for a Simpler World

LIQUID COMPRESSION TECHNOLOGY

Gas is transported in a liquid state after being compressed. But what about liquid? Liquid is difficult to compress, so water pipes and gas pipes must remain a certain size, as must the gas tanks in automobiles.
The technology for compressing liquid has been studied in hopes of figuring out easier ways to carry and store liquid. If successful, this research would perhaps make it possible for a bottle of water to satisfy as many as 100 thirsty people.

CAR COLORED WITH "CHAMELEON PAINT" IS AWARDED FIRST IN CUSTOMER SATISFACTION!

You Can Choose Any Color, Any Time

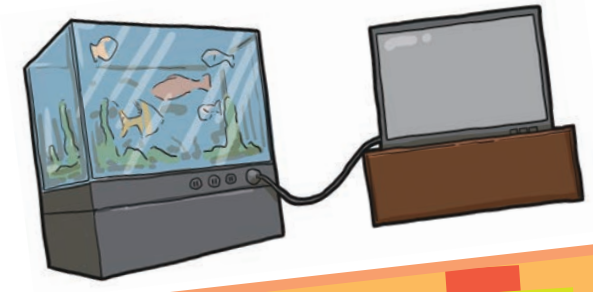
In the future, we'll be able to change the color of our car to whatever we want, whenever we want. Paint contains pigments that allow our eyes to recognize various colors. If we can change the structure of the molecules that form the pigment, we will be able to change the color of our cars without having to apply additional coats of paint. Paint that changes color when ultraviolet rays or heat cause changes in its molecular structure of molecules already exists. Soon, we will be able to change the color of paint whenever we wish, saving us the inconvenience of having to live with whatever color we originally chose.

Molecule: **The tiniest chemical substance that retains the unique properties of matter and can exist by itself.**

RECHARGE YOUR ELECTRICITY SUPPLY THROUGH "BIOENERGY AQUARIUMS"

Aquariums Harvesting Bioenergy from Sea Creatures Go Global

With the invention of submarines that can dive far beneath the ocean, new sea creatures have been found. Among them are amazing animals that can produce electricity or hydrogen and even control their body temperature. Maybe in the future, every home will have these animals in aquariums and can use them for energy sources. Such aquariums would provide enough electricity to run the thermostat or watch TV!!



AD

DELICIOUS "GENE REPLICATOR" BUY VARIOUS ELECTRONIC FOOD CHIPS AT A STORE NEAR YOU!

This replicator produces cloned vegetables whenever electronic food chips containing vegetables' genetic information are inserted. It's not merely a dream, because cloning technology has developed rapidly in recent years. The day when we can buy genetic chips of different foods from various localities, and use them to whip up a delicious meal, is rapidly approaching.

PART 4
BALANCE AND INVENTION

Keep your Balance!

American high-wire artist Nik Wallenda was the first person to wire-walk across the Grand Canyon without any safety device. He also succeeded in wire-walking 475m above the Little Colorado River in northern Arizona for 6 minutes without a net. He even succeeded in a high-wire crossing over the 61meter-high Niagara Falls.

When we see someone walking on a tightrope break a world record, we realize there is no limit to the human spirit.

How can you learn to walk all the way across such a dangerous tightrope?

Let's look into the
balance principle
of invention

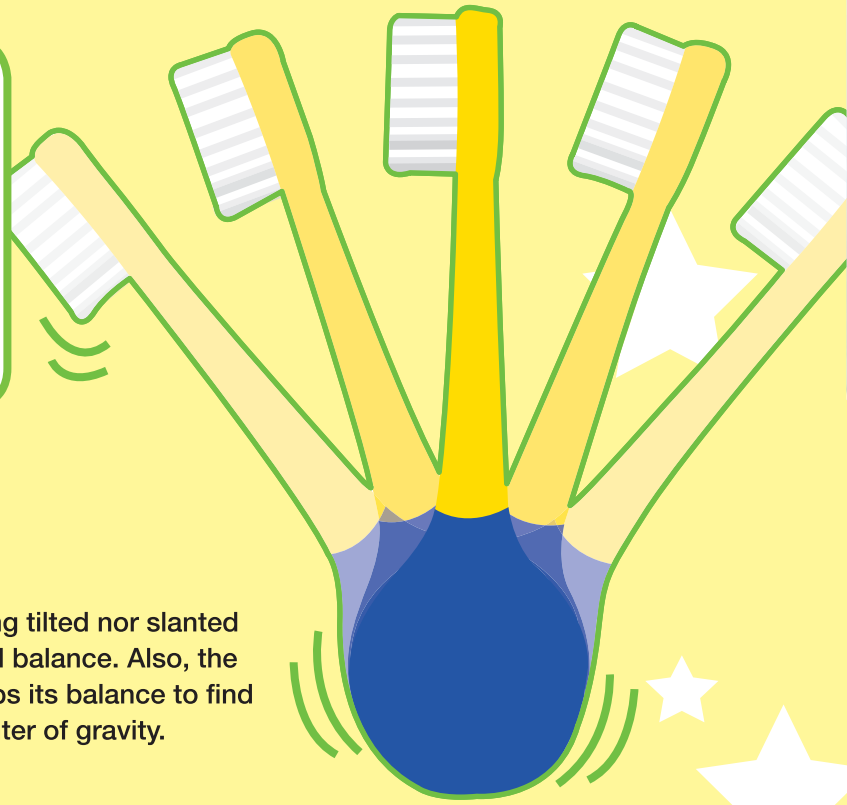
PREVIEW

THE INVENTION OF THE ROLY -POLY TOOTHBRUSH USING THE PRINCIPLE OF BALANCE

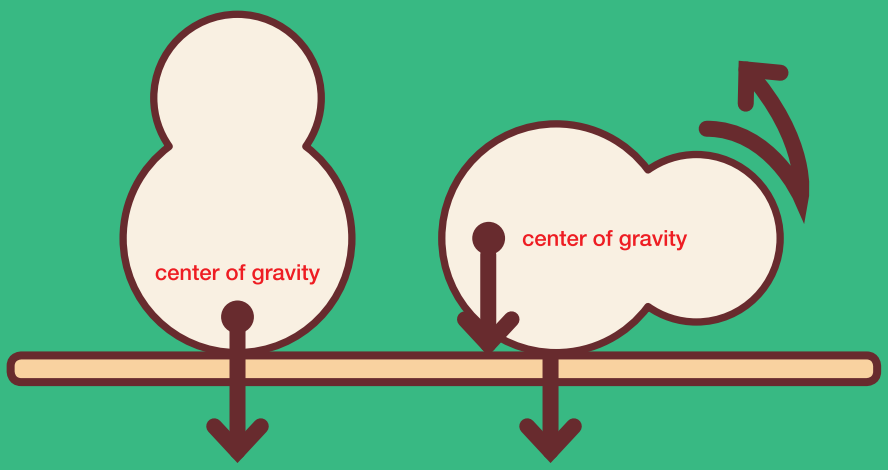
Looking into the balance principle via the roly-poly toothbrush.

A ROLY-POLY is a toy that rights itself whenever it is knocked over. The name comes from the self-righting characteristic of the toy.

A ROLY-POLY TOOTHBRUSH is an invention that is both hygienic and fun, since it is designed to remain upright and be enjoyable for children.



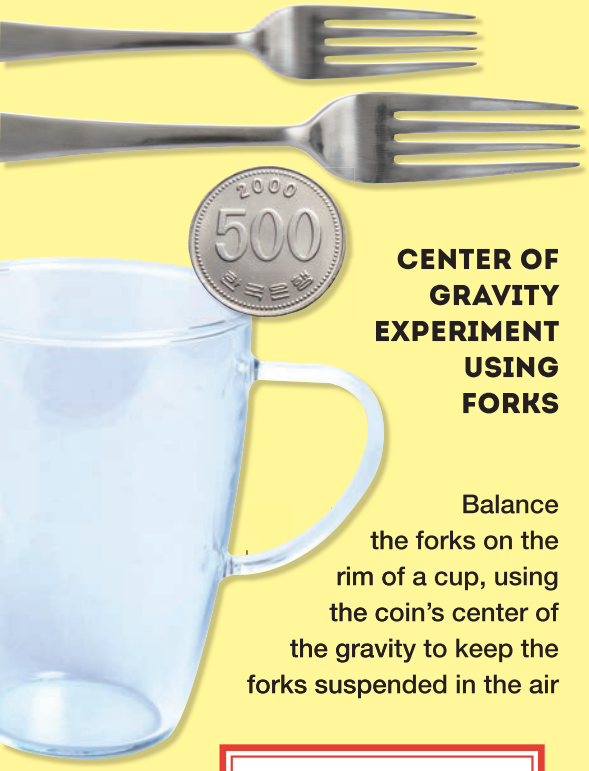
This “even” state, not being tilted nor slanted towards any side, is called balance. Also, the point where the object keeps its balance to find equilibrium is its center of gravity.



The purpose of the roly-poly toy is to remain upright. The bottom of the toy is round, and the toy is heaviest at the point where it contacts the ground. When the toy is knocked over, its heaviest point goes up into the air, but is quickly brought down again by the force of gravity. This is the principle that makes the rolypoly toy work.

LET'S THINK ABOUT CENTER OF GRAVITY

EXPLORING PRINCIPLE 1



CENTER OF GRAVITY EXPERIMENT USING FORKS

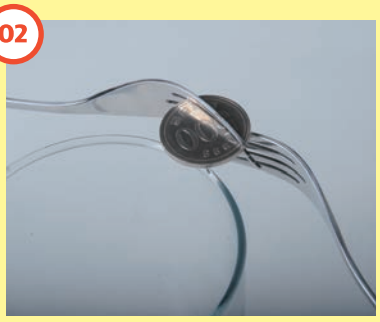
Balance the forks on the rim of a cup, using the coin's center of the gravity to keep the forks suspended in the air

Prepare 2 forks, 1 glass cup, and 1 coin.

01

Overlap the 2 forks with the coin in-between.

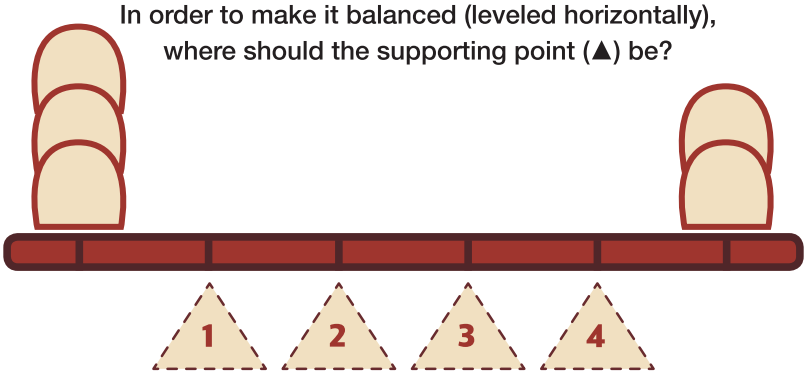
02



Put the structure on the rim of a cup, keeping it well-balanced.

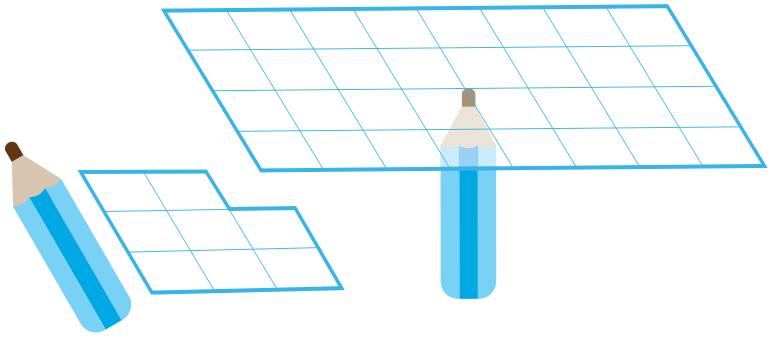
The center of gravity principle.

In order to make it balanced (leveled horizontally), where should the supporting point (▲) be?



We want to balance the following paper on the tip of a pencil. Find the center of gravity and make a dot. Then practice it again using the suggested materials.

(Material: pencil, Supplement 03)



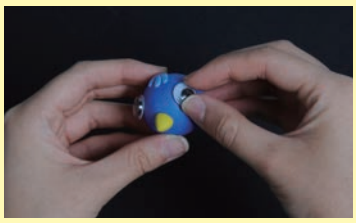
EXPLORING PRINCIPLE 2

MAKE A BALANCING BIRD BY USING THE CENTER OF GRAVITY

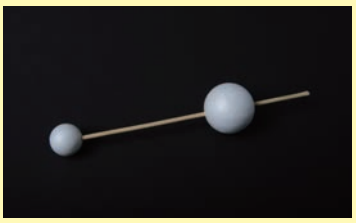
Make a bird by applying the principle of center of gravity

a Styrofoam ball (or Styrofoam packaging material), a lollipop or some rubber clay, decoration materials (i.e., stickers or a marker), wooden sticks – approx. 25cm (1), and 17cm (2)

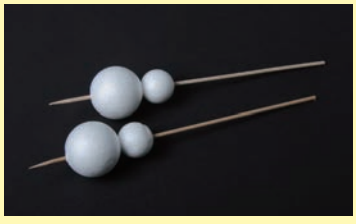
HOW TO MAKE THE BIRD

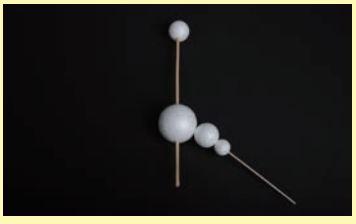


Cut the Styrofoam into 3 different pieces. (5x5cm, 3x3cm, 2x2cm)

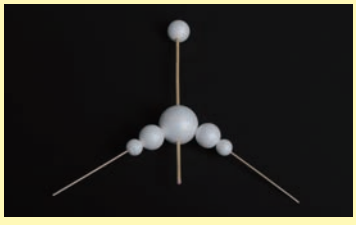


Stick the 5cm and 3cm Styrofoam balls onto a 25cm wooden stick.

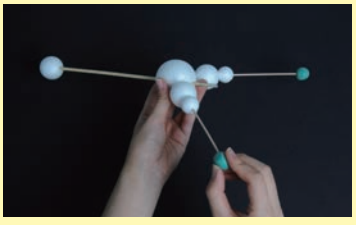




Stick the 3cm and 2cm Styrofoam balls onto 17 cm wooden sticks (make 2 sets).



Stick the other 17cm stick on the opposite side of the 5cm ball in the same manner.



Stick two lollipops (or pieces of rubber clay) on the pointy ends of the 17cm wooden sticks.

NEWER AND MORE FUN

- Change the balancing point
- Adjust the angle of the bird's wings
- Predict the resulting changes in flight
- Practice it further with other objects

LOTS OF EVERYDAY INVENTIONS USE THE BALANCE PRINCIPLE.

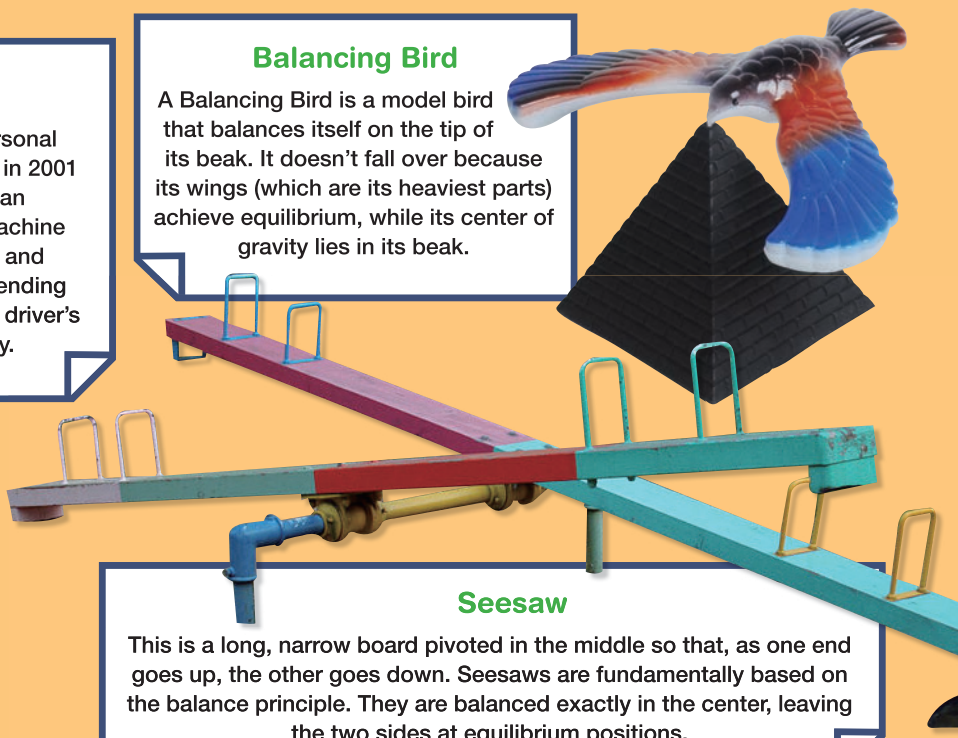
There are lots of inventions around us that use the balance principle.

Segway

The Segway is a personal transporter created in 2001 by the inventor Dean Karmen. This machine moves forward and backward depending on shifts in the driver's center of gravity.

Balancing Bird

A Balancing Bird is a model bird that balances itself on the tip of its beak. It doesn't fall over because its wings (which are its heaviest parts) achieve equilibrium, while its center of gravity lies in its beak.



Seesaw

This is a long, narrow board pivoted in the middle so that, as one end goes up, the other goes down. Seesaws are fundamentally based on the balance principle. They are balanced exactly in the center, leaving the two sides at equilibrium positions.

Look into the characteristics of the following inventions that use the balance principle. Write down their advantages.

standing spatula

This spatula avoids touching other surfaces, making it more hygienic.

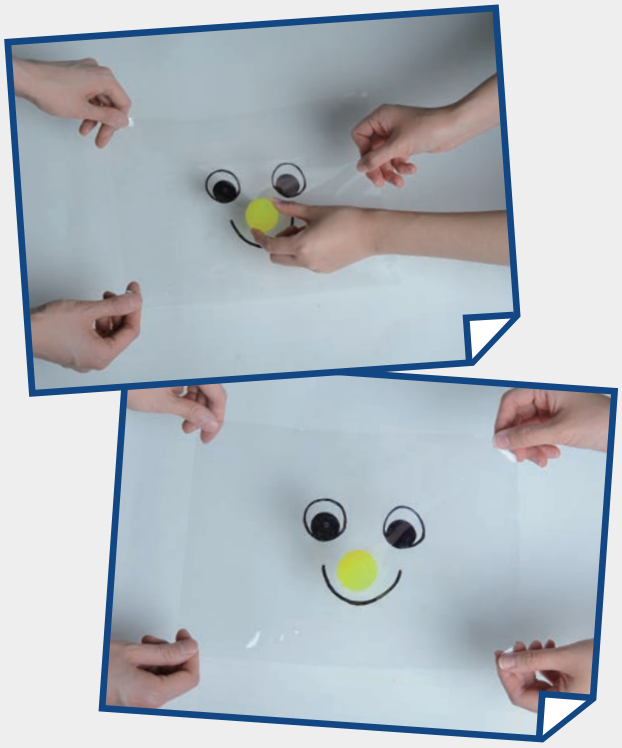
standing iron

a pair of scales

INVENTION EXPERIMENT

THINK AGAIN

Let's play a balancing game.



WHAT IS NEEDED?

A1-sized plastic (or paper) bag, marker, and small-sized ball

HOW TO PLAY?

1. Draw eyes and a mouth on the plastic bag.
2. With two people holding the ends of the plastic bag, place the ball in the "nose" position.
3. Stretch and hold the plastic bag.
4. If the ball can't remain balanced and falls off the bag, the game is over.

Now, make a new balancing game using different materials.

WHICH MATERIALS SHOULD WE CHANGE TO MAKE THE NEW GAME? CIRCLE(○)YOUR CHOICES.

Plastic bag, marker, ball

IN GROUPS, DISCUSS WHICH MATERIALS SHOULD BE REPLACED. WRITE ABOUT THE POSSIBLE EFFECTS IF THESE MATERIALS ARE CHANGED.

ex) material to be replaced: replace the plastic bag with a wooden board.
ex) effect: The ball will fall off if the board isn't held perfectly horizontally.

material to be replaced:

effect:

Explain the experiment to your friends.
Play the game in a group.

SELECT THE MOST INTERESTING GAME ACCORDING TO THE FOLLOWING PERSPECTIVES.

Perspective 1 Does it use the balance principle?
Perspective 2 Does the game contain any new ideas?
Perspective 3 Is it fun?

BRIEFLY EXPLAIN THE SELECTED GAME THROUGH WRITING OR DRAWINGS.

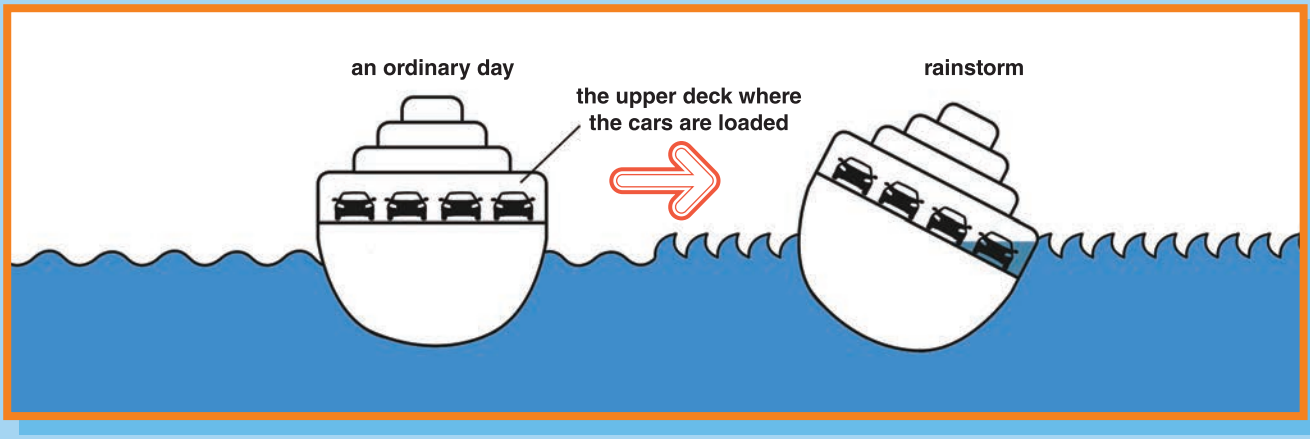
PLAY THE SELECTED GAME IN A GROUP AND DISCUSS YOUR REACTIONS.

STORY OF BALANCE

WHAT DO I DO?

Stop the ship from sinking!

A huge ferry with many passengers and cars ran into a storm and sank. Despite the belief that the ship wouldn't sink so easily, this particular ship plunged down rather quickly, despite of its large size. The upper deck without a roof had many cars on it, and the lower deck contained passengers in a cabin where water was unable to seep in. As the heavy rain and high waves filled the ship with water, the ship's balance began to shift. This was the cause of the shipwreck.



HOW COULD A SHIP WITH WATER GUSHING IN BE SAFELY RESCUED BEFORE IT FLIPS OVER? WHAT WAYS CAN YOU THINK OF? WRITE YOUR IDEAS.

RECALL THE INVENTION EXPERIMENT AND WRITE AN ENTRY IN THE CREATIVE INVENTION JOURNAL.

Title :

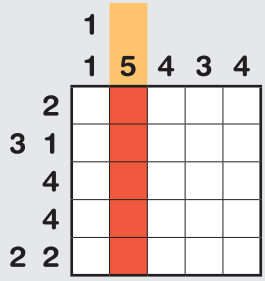
DRAWING PICTURES BY BALANCING NUMBERS

SQUARE, SQUARE LOGIC

WHAT IS SQUARE, SQUARE LOGIC?

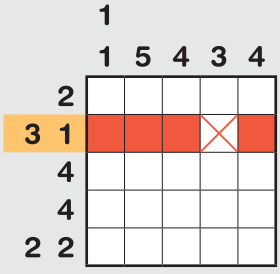
It is a game where you uncover the underlying picture by using number clues on a piece of graph paper.
The picture can be completed once the clue sequences are filled in on the horizontal and vertical lines.

THIS IS HOW YOU PLAY THE SQUARE, SQUARE LOGIC GAME!



01 **Spaces should be colored-in as you follow the marked numbers either horizontally or vertically.**

- On the graphing board, the number on the left (horizontal) and the one on the top (vertical) indicate how many spaces you need to color-in to complete the sequence.
- If it shows the number 2 on the left (horizontal), and the number 5 at the top (vertical), then you will need to color-in two consecutive squares in the horizontal row and 5 squares in the vertical column.

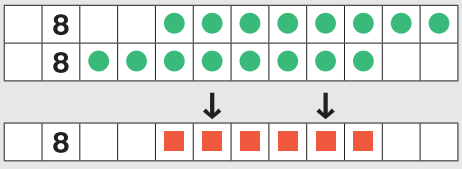


02 **Caution! There may be more than one number listed on the side.**

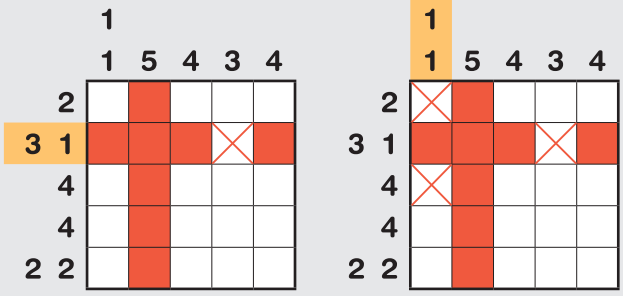
- This means there may be one or more empty spaces between the groups of colored-in spaces.
- For example, if it says 3 and 1 on the left side, that indicates an empty space between a group of 3 colored-in spaces and 1 additional colored-in space in that row.

03 **Spaces that can be colored-in are found through intersection points.**

- Intersection points are overlapping places from the top, bottom, left, or right.

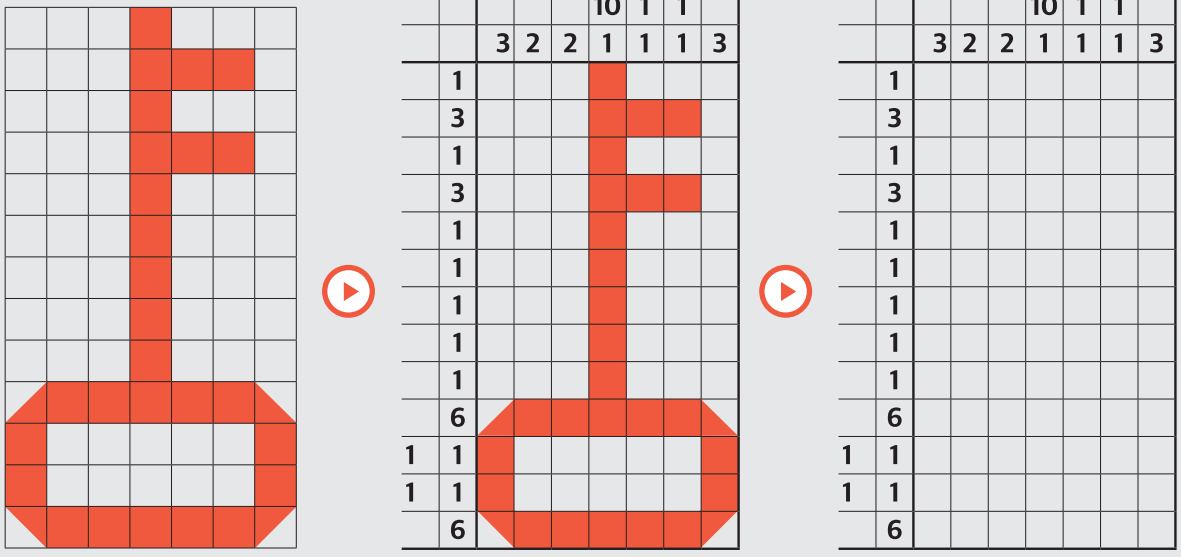


04 **Mark X on the spaces that can't be colored-in.**



MY OWN SQUARE, SQUARE LOGIC GAME!

1. Draw any object you like.
2. Color-in all the squares included in your drawing.
3. Number the left side and top side, indicating the number of squares that have been colored-in.
4. Erase the picture, leaving only the numbers. This is how the game is made.



LET'S PLAY SQUARE, SQUARE LOGIC GAME!

1. Solve the Square, Square Logic problem using Supplement 04.
2. Make a Square, Square Logic game using Supplement 04. Then switch papers with a friend and begin playing.

PART 5
ACTION, REACTION, AND INVENTION

Who am I?

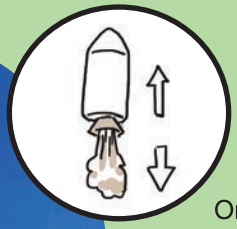
I exist in birds' flapping wings and in speeding cars.
I result when swimmers suddenly change direction.
People can walk because of me.
I don't exist alone, though.
Action and reaction exist in two separate objects.
Reaction is created through action. We always exist together.

Let's look at inventions that
use action and reaction

PREVIEW

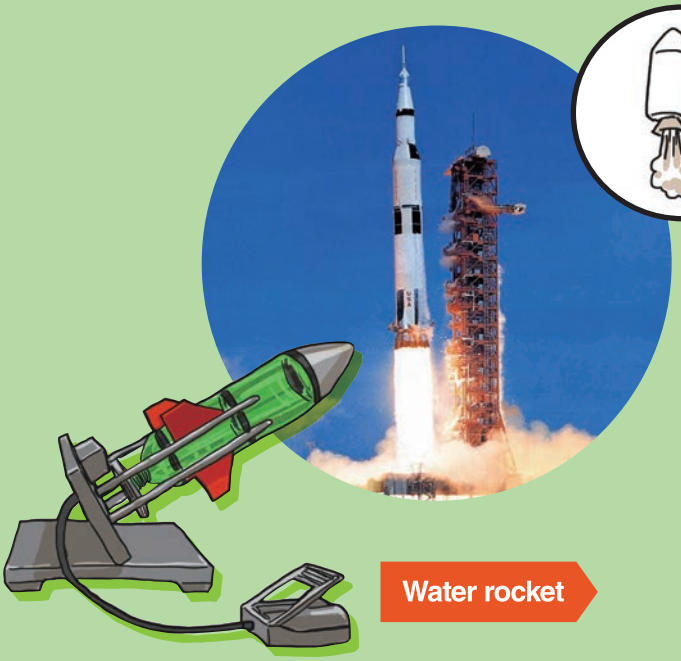
THE INVENTION OF ROCKETS USING THE LAW OF ACTION AND REACTION

Take a look at the rocket—the perfect example of an invention that uses the law of action and reaction



THE ROCKET IS ACCELERATED BY GAS SPRAYED FROM BURNING FUEL.

One type of rocket accelerator is a jet engine based on the principle of using sprayed gas as the driving force.



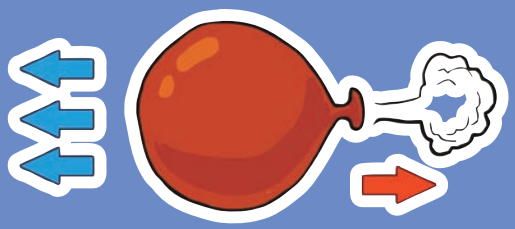
Water rocket

WATER ROCKET: Compressed pressure in the interior space pushes the water out of the plastic bottle (action), and, as a response, the plastic bottle moves forward from the force of the water's escape (reaction).

Air rocket

AIR ROCKET: Stepping on the pump causes air to push against the rocket. The rocket reacts by pushing against the pump.

In regard to the law of action and reaction, explain what will happen to a fully blown balloon when it's released without being tied at its end.

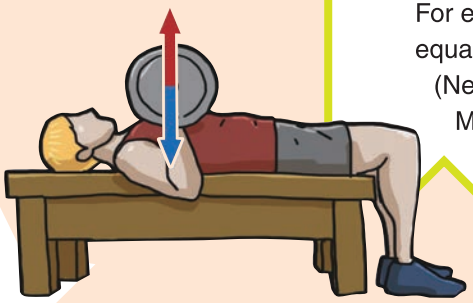


See if you can find more examples like this.

When you let go of an air-filled balloon, it, along with the air inside, will move in the (same, opposite) direction. At this point, the balloon contains the (action, reaction), while the released air contains the (action, reaction).

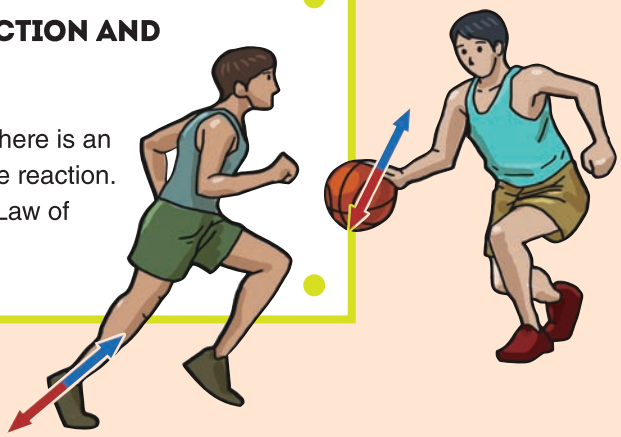
PRINCIPLES OF THE LAW OF ACTION AND REACTION

EXPLORING PRINCIPLE 1



THE LAW OF ACTION AND REACTION

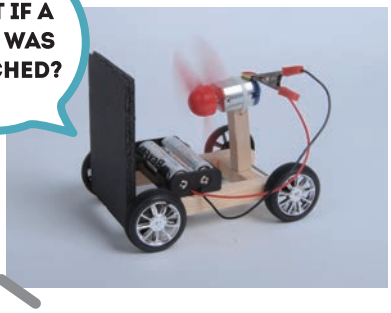
For every action, there is an equal and opposite reaction. (Newton's Third Law of Motion)



The following diagrams show a propeller mini-car that uses the law of action and reaction to move.

This propeller car reacts by moving forward whenever the propeller pushes the air backward. However, if the back of the car was blocked (as in the illustration below), what would happen?

WHAT IF A WALL WAS ATTACHED?



The car would ( ).
This is because

EXPLORING PRINCIPLE 2

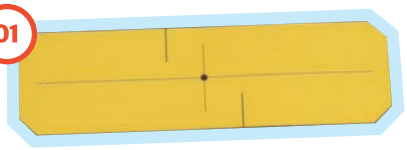
MAKE A "FLYING HELICOPTER!"

Make a helicopter that uses the law of action and reaction. (Use Supplement 05)

Preparation Material

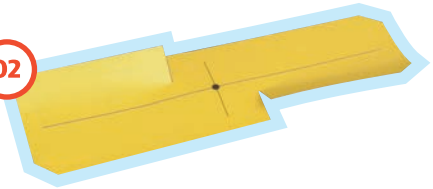
a wooden stick (15 cm), an awl, Supplement 05 (or thick paper, scissors, and a ruler).

01



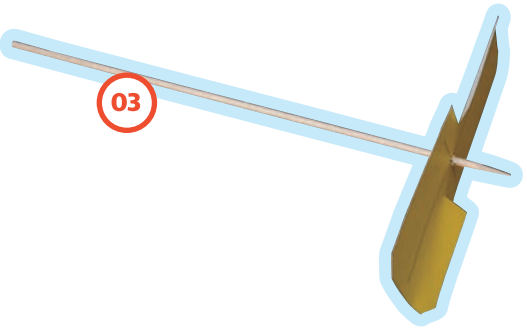
Cut the thick paper into a suitable size for the wings (3cm×10cm). Then draw a line horizontally and vertically through the middle, as shown in the picture (Supplement 05 can be used).

02



1 cm away from the middle point, make a cut and fold up the paper to make the propeller blades.

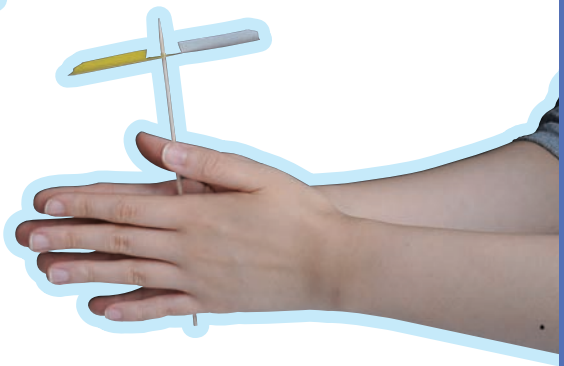
03



Use an awl to make a hole in the middle, and put a wooden stick in the hole to complete it.

04

FLY IT: Place the wooden stick between the palms of your hands and rub your hands together while spinning the stick.



Tip → It is important to note the direction in which the propeller is bent.

AFTER EXPERIMENTING WITH THE HELICOPTER YOU MADE, CONCLUDE BY DISCUSSING THE LAW OF ACTION AND REACTION.

When the propeller spins, the air around it is pushed down ( ). As a ( ) to this, the helicopter takes off into the air.

NEWER AND MORE FUN

- Try to fly it as high as you can.
- Try to fly it as far as you can.
- Try to fly it towards a specific target.
- Design a new helicopter.

INVENTIONS THAT USE THE LAW OF ACTION AND REACTION

EXPLORING INVENTIONS

Let's look at inventions that use the principle of action and reaction.

Water Jet Pack *Fly Board*

The water jet pack *Fly Board* uses the jet ski's driving force to draw in water and spray it back out. The force of the water spraying in the opposite direction allows the rider to hover in the air.

Hovercraft

The hovercraft uses a propeller to blow strong wind against the surface below. This force creates a reaction that allows the craft to hover. The vehicle then uses another propeller positioned at the back to propel itself forward.

Recoilless Rifle

Gas pushed from the back of the recoilless rifle is accelerated to supersonic speeds, causing the bullet to move forward in the direction the gun is pointed. This approach prevents the shooter from feeling any impact from the gun's recoil.

Determine the force of action and reaction, as well as their effects, from the following inventions:

▲ **Balloon-Powered Toy Car**

▲ **Tire**

▲ **Oar**

▲ **Firecracker**

INVENTION EXPERIMENT

THINK AGAIN

Following the invention method, design a new toy by utilizing the law of action and reaction.

Stage 1

Plan ideas by following the suggested outline

Condition 1

MOBILIZATION ENERGY FOR MAKING THINGS MOVE

(Which energy source are you going to use?)

ex) water, wind, vapor, elasticity (rubber band), vibration, gun powder, etc.

ex) Energy source of the toy

EX) **ELASTICITY** (rubber band)

ex) Energy source of my toy

Condition 2

SHAPE OF THE TOY THAT YOU WANT TO MAKE

(What shape/design will it be?)

ex) car, boat, rocket, train, etc.

What shape will it be?

EX) **BOAT**

Planned shape for my toy

Condition 3

BASIC MATERIALS NEEDED

(What materials would be effective?)

ex) plastic bottle, Styrofoam board, paper box, recycled CD, motor, rubber band, balloon, etc.

Materials needed

EX) **STYROFOAM BOARD, RUBBER BAND, TRANSPARENT TAPE**

Materials needed for my toy

Stage 2

Briefly explain how the toy moves.

ex) The elasticity of the rubber band wrapped around the oar causes it to unwind and push back the water (action). Then the boat moves forward (reaction).

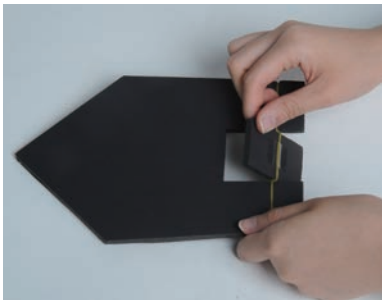
Explain how my toy moves.

Stage 3 Draw a diagram to show the method of movement

borrow other people's ideas

DIAGRAM
(Example)

moves forward
(reaction)



The car pushes the water (action)

By the elasticity of the rubber band, the oar unwinds and pushes back the water. Then the boat moves forward.

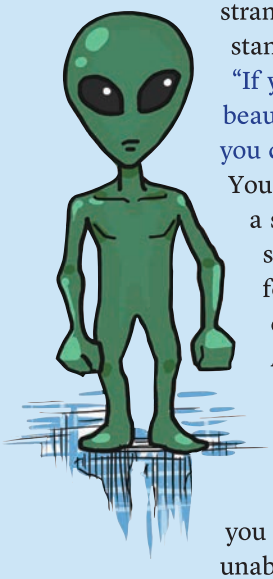
BLUEPRINT OF THE TOY I DESIGNED

Listen to other students' presentations and present your work using your blueprint.

STORY OF ACTION AND REACTION

WHAT DO I DO?

NO ESCAPE FROM AN ICY ROAD



An alien suddenly appears from the skies. It kidnaps you and leaves you stranded in the middle of an icy road with absolutely no frictional force. As you stand there stunned, you hear the alien's voice echo,

"If you manage to escape this icy road, I shall give you a planet much more beautiful than Earth. I will also provide you a spaceship and friends. However, if you cannot, you will be left here forever."

You respond, "That's easy!" and confidently put your right foot forward to take a step. However, before your right foot can touch the icy road, your left foot slips. Immediately after, you get up and attempt carefully to take another step forward, but it slips once again. This repeats over and over until you've lost all energy to get back up. You have been slipping in the same spot for a long time.

After thinking about it, you consider the possibility that the alien that kidnapped you might have come from a planet where Newton's Laws of Motion don't apply.

"Did they want to see what the Law of Action and Reaction was by putting me in the middle of this icy road?" you ponder. Unfortunately, no matter how hard you try, you are unable to walk away from the spot where you've been standing and slipping. Even when you put all your effort into placing your right foot forward to walk, due to the laws of action and reaction, your other foot slides forward as well. Crawling doesn't seem to be an option either.

HOW CAN I GET OUT OF THE ICY ROAD?

Write down your ideas.

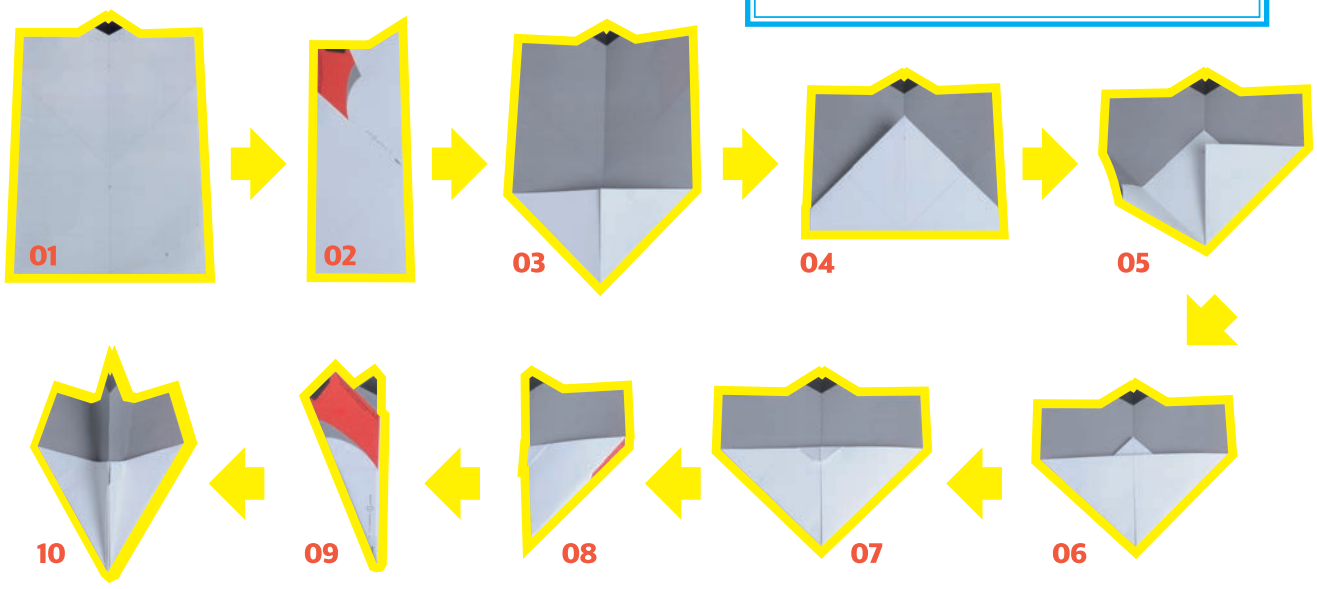
RECALL THE INVENTION EXPERIMENT AND WRITE AN ENTRY IN THE CREATIVE INVENTION JOURNAL.

Title :

ADJUSTING THE FLIGHT OF A PAPER PLANE

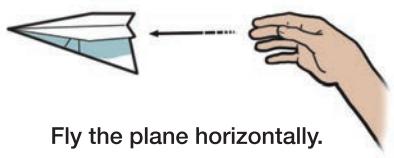
MAKING MY OWN PAPER PLANE

Use Supplement 06 to make the following paper plane.

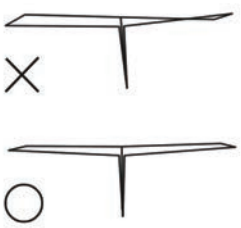


PLANE ADJUSTMENTS

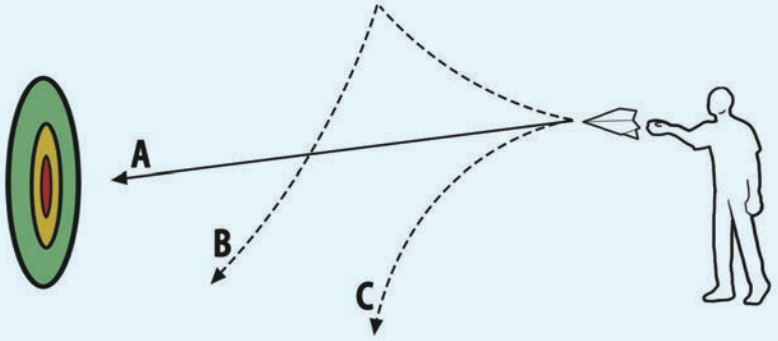
Plane Adjustments



Fly the plane horizontally. When flying the plane, throw it as if you are pushing it from the back.



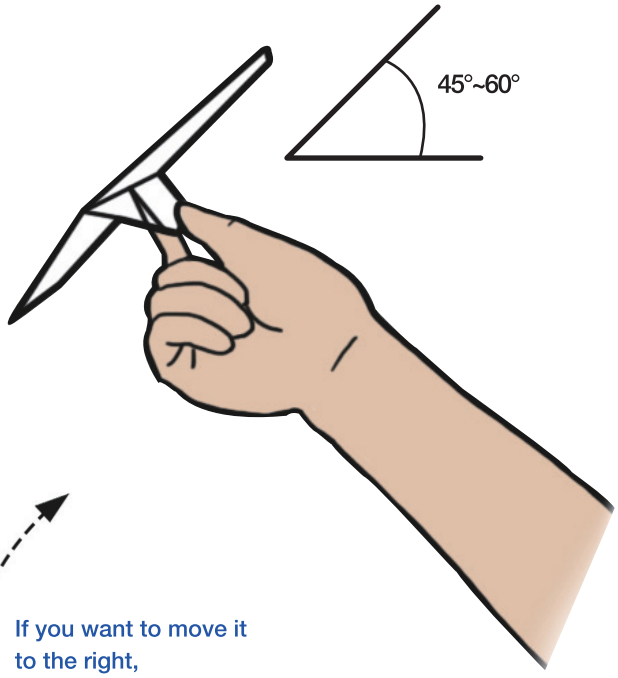
Make sure each wing is not bent to any side when looked at from the front. Make sure both wings are symmetrical.



If the plane flies toward A, it is adjusted correctly. If it flies in the direction of B, bend down the back of the wings. If it flies in the direction C, slightly bend up the back of the wings.

ADJUSTING THE FLIGHT OF THE PLANE

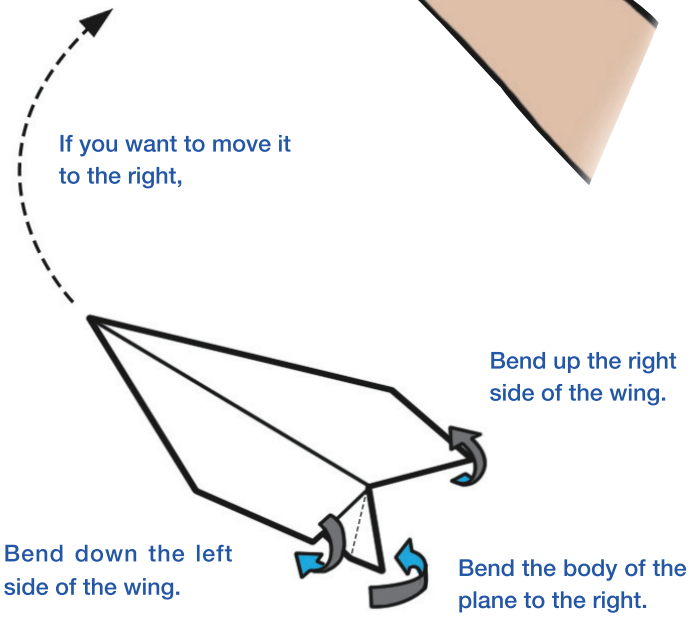
To make the paper plane fly longer, throw the plane at a 45°-60° angle. This helps the plane fly longer in a circular pattern.



TO DIRECT THE PLANE TO THE LEFT OR RIGHT

If you want to direct the plane to the left or right, slightly bend the edges of the wings, or the body of the plane.

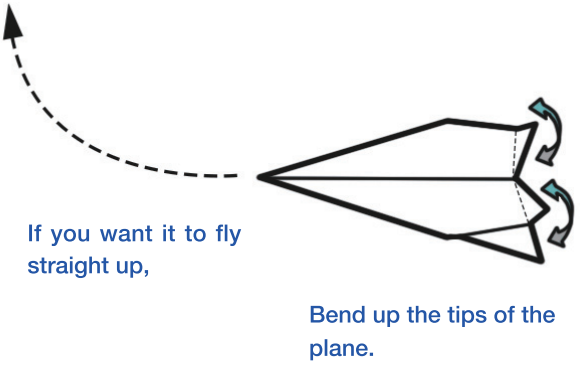
(If you want to direct it to the right, follow the steps in the illustration. If you want to direct it to the left, do the exact opposite.)



TO DIRECT THE PLANE UP OR DOWN

If you want to direct the plane up or down, slightly bend the nose of the plane.

(If you want to direct it upward, follow the directions in the illustration. If you want to direct the plane downward, do the exact opposite.)



PART 6

SOUND AND INVENTION

Can an unborn baby hear his or her mother's voice?

What kind of sound would an unborn baby make?
Fetuses feel safest when they hear their mother's voice and can recognize it. They can also listen to music from inside the belly and dance along with the beat. For these reasons, during pregnancy, parents often tell stories and play music as a form of prenatal education.

How can an unborn baby hear sound?
Not only can a fetus hear its mother's voice through sound waves in the air, but, while in the womb, it "hears" the vibrations that pass through the mother's body.

How can we help unborn babies hear the voices of their parents more clearly?

Let's look into inventions
that use sound

PREVIEW

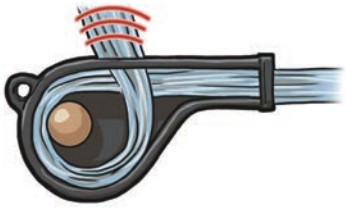
INVENTION OF THE WHISTLE, USING SOUND

The whistle is the perfect example of an invention that utilizes sound.

The part into which we blow air is called the mouth piece. When air enters into it, it splits into two streams upon reaching the square-shaped slit at the back of the whistle. As the air exits, it vibrates and produces sound.

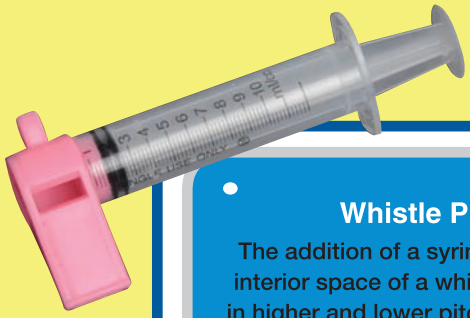
At this point, the tiny ball inside the whistle interrupts the vibrations and changes the quality of the sound. The end result is the characteristic whistle sound we all recognize.

Let's discover how whistles use the principle of sound.



As the air blown inside goes out through the hole,
the upper stream of air produces a particular sound wave, as the lower stream rushes around in a circle inside the whistle. As the air exits, the upper sound wave is then amplified.

Electric Whistle
A whistle that is used by pressing upon it with your hands.



Whistle Pipe
The addition of a syringe alters the interior space of a whistle, resulting in higher and lower pitches in sound.

THE PRINCIPLE OF SOUND

EXPLORING PRINCIPLE 1

Discuss ways of generating sound.

Experiment 1

WHAT WOULD BE THE DIFFERENCE IN SOUND BETWEEN TAPPING ON A GLASS THAT IS FULL OF WATER AND ONE THAT ONLY HAS A LITTLE WATER INSIDE?

A glass that is full of water would make a (high-pitched, low-pitched) sound.

A glass with only a little water inside would make a (high-pitched, low-pitched) sound.

In regard to sound, as the weight of an object decreases, its vibration (increases, decreases).

3 ELEMENTS OF SOUND

Pitch, Loudness, Timbre,

Experiment 2

Explore how sound is generated by making a device that makes sounds like a duck.

01

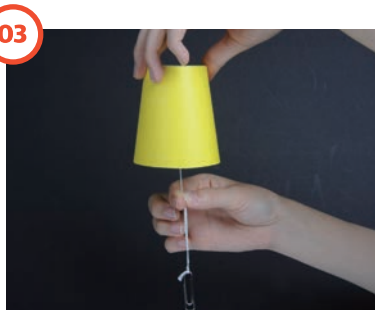
Paper cup (if not available, use Supplement 07), string, paperclip, transparent tape, awl, sponge, and water.

Make a hole in the cup, and run a string through it.

03

Tape the string to the bottom of the paper cup.

03



Wet the string slightly with water and pull it back and forth through the hole in the cup.

Exploring Activity

Pluck and pull at the string to makes sounds. What do you feel on your finger?
Talk about ways of making different sounds in relation to Experiments 1 and 2.

Wrap Up

Sounds are made by the frequency of vibrations. Every object makes different sounds due to its unique frequency of vibrations.

EXPLORING PRINCIPLE 2

MAKE A "BALLOON PIPE"

Fashion a balloon pipe that makes funny sounds!

balloon, straw, scissors, transparent tape, OHP film (Laminating Film)

EXPLORATION ACTIVITY

ARE THE SOUNDS OF ALL BALLOON PIPES THE SAME?

Discuss the various sounds of the balloon pipe.

HOW TO MAKE A BALLOON PIPE

01

Use scissors to cut the straw to any length you wish.

02

Make a reed with the OHP film.

03

Tape the reed onto the tip of the straw.

04

Insert the end of the straw with the reed into the balloon.

05

Tape the straw and the balloon together.

06

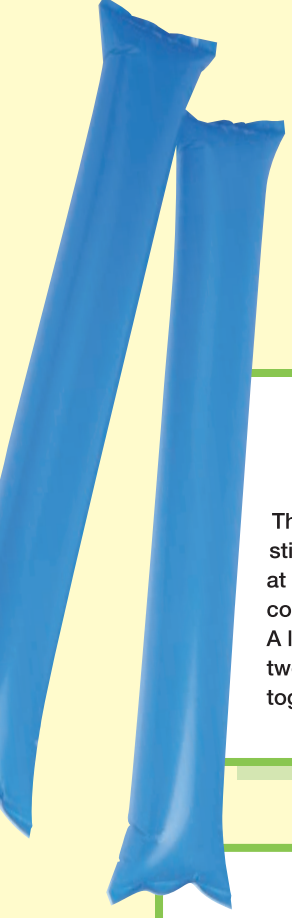
Blow into the balloon and check out the sounds.

NEWER AND MORE FUN

Differentiate the lengths of the straws → Differentiate the thickness of the straws → Differentiate the sizes of the balloons → Design a new pipe

INVENTIONS RELATED TO SOUND

Here are some common inventions related to sound

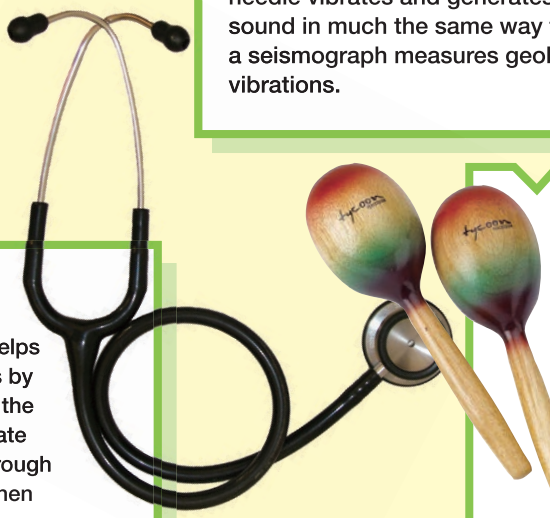


Cheerleading Stick Balloon

This is a plastic or vinyl stick used for cheering at events like sports competitions and concerts. A loud noise is made when two balloon sticks are hit together.

Phonograph Record

The phonograph plays records by reading the wavy patterns (grooves) engraved in zigzag patterns on them. As the record rotates, the phonograph needle vibrates and generates sound in much the same way that a seismograph measures geological vibrations.



Stethoscope

The stethoscope is a medical tool that helps doctors diagnose physical abnormalities by enabling them to listen to sounds inside the body. Sounds from a person's body vibrate the film in the stethoscope and move through the connected tube. Those sounds are then transferred to the doctor's ears.

Maracas

Maracas are popular rhythmic instruments used in various sorts of music. When a maraca is shaken, the seeds inside the hard outer layer hit the inner wall and produce sounds. Maracas that emit a high-pitched sound are often used in conjunction with ones that emit low-pitched sounds.

Consider the uses of inventions that use sounds.

Alarm clock

It uses sound to alert us at a pre-determined time.

Telephone's ring

Doorbell

INVENTION EXPERIMENT

LET'S ALTER THE DESIGN!

Using the "addition" method of invention, add sound to a typical object and come up with a step-by-step invention plan for your design.

EXAMPLE

OBJECT	+	SOUND	→	INVENTION	EFFECT
	+		→		The sound lets us know when there is an emergency.
	+		→		The sound lets us know when the water is boiling.

STAGE 1

Design various inventions that use sounds, as shown in the examples above.

STAGE 2 : APPLYING THE PRINCIPLE OF SOUND TO IMPROVE AN EXISTING INSTRUMENT AND TRANSFORM IT INTO SOMETHING NEW.

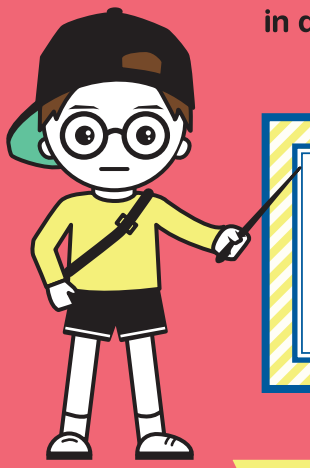
INSTRUMENT	AREAS OF NEEDED IMPROVEMENTS	APPLYING THE PRINCIPLE OF SOUND TO SOLVE PROBLEMS	PRIORITIZE THE RANKING
Recorder	1. I would like to make it lower in pitch	It can be temporarily elongated.	
	2.		
	3.		
Bongo	1.		
	2.		
	3.		

Make a detailed design for the #1 ranked improvement listed above.

STORY OF SOUNDS

INVENTION FOR THE VISUALLY IMPAIRED

There are some things that visually challenged people have difficulty doing. Below is a list of the top 5 things that visually challenged people would like to accomplish more easily. Think of ways you can assist them in doing these things. Your ideas must involve the usage of sound.



1. I would like to know whether the bus I need to take has arrived.
2. I would like to be able to vote.
3. I would like to leave a reply on a message board on the internet.
4. I would like to safely get to my destination without help from others.
5. I would like to see my face in the mirror to check if I look OK.

Select the problem you would like to solve, and think of ideas.

Problem to be solved 1:
Idea:

Problem to be solved 2:
Idea:

PROBLEM SOLVING IDEA 1

Express your ideas by drawing them.

PROBLEM SOLVING IDEA 2

RECALL THE INVENTION EXPERIMENT AND WRITE AN ENTRY IN THE CREATIVE INVENTION JOURNAL.

Title :

WHAT IS SOUND?

Sounds are made from vibration.

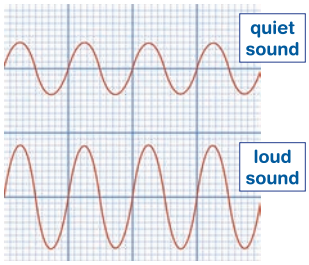
The principle of sound is based on vibration. The beautiful sounds of a violin or guitar come from the vibration of the strings. The human voice works the same way. Our voices are made through the vibration of our vocal cords. When you say "Ah~" and touch your neck, you can feel the vocal cords vibrate. The appearance of an object trembling is called "vibration."

Sound needs air

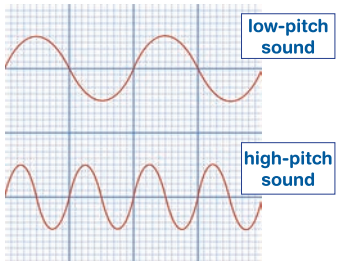
Just as we need air to live, we also need air to deliver sounds to our ears. How does this work? The vibration of an object is transmitted to the air, which then vibrates in the same fashion as the object. Those vibrations are carried through the air until they reach our eardrums. Any kind of matter that transmits sound is called a "medium."

High and low pitches, and sound volume

"In public, you have to speak quietly." "A woman's voice is higher than a man's voice." "What does it mean for sounds to be quiet or high?" First, the pitch of the sound being high or low is decided by the number of vibrations, or how frequently a voice trembles. If there are many vibrations, it is a high-pitched sound, and if there are fewer vibrations, it is a low-pitched sound. The loudness of sound is related to the width (amplitude) of the vibration. As the amplitude gets larger, loud sounds are made, and as the amplitude gets smaller, quiet sounds are made.



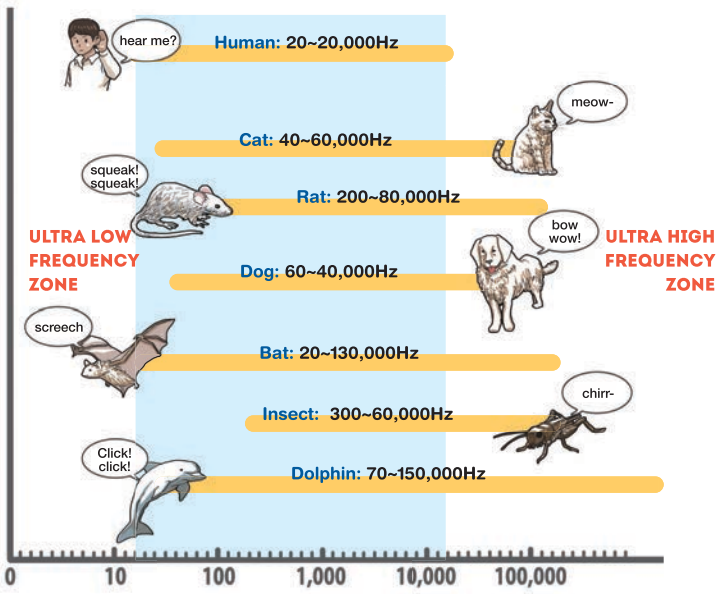
(a) the pitch of sound is the same



(b) the strength of sound is the same

Sounds that humans can't hear

Why can't we hear ultrasonic waves made by dolphins and bats? This is because the sounds we can hear range from 16 (16Hz) vibrations per second to 20,000 (20,000Hz=20kHz) vibrations per second.
If the number of vibrations is lower than 16Hz or larger than 20,000Hz, the sounds can't be heard by human ears. The range of sounds we can hear, or the range ofvibrations from 16Hz~20kHz, is called the audio frequency, and the sounds we can't hear that are greater than 20kHz are called ultrasonic waves.



Inventions that use the Ultrasonic Wave

01 Ultrasound Medical Equipment

Ultrasonic waves are used by hospitals to look inside patients' bodies. Ultrasound medical equipment operates on the principle that sound waves reflect off of the objects they encounter. When ultrasound equipment is placed on a pregnant woman's belly, ultrasonic waves reflect off the unborn child. These reflected waves are converted into visible data, giving an image of the baby.

02 Ultrasonic Wave Washer

Ultrasonic waves vibrate over 20,000 times per second. Therefore, if ultrasonic waves enter water, air bubbles are formed. These air bubbles act like tiny vacuum cleaners by peeling debris off the surface of objects. Several kinds of equipment use this technology to clean things like cars and fruit. There is also an ultrasonic wave washer invented for domestic use.

03 Ultrasonic Wave Mosquito Eradicator

The most irritating thing about summer are the mosquitoes. When it is time for female mosquitoes to lay eggs, they tend to avoid male mosquitoes. The ultrasonic mosquito eradicator is an invention that uses this fact of nature. It gives off the same frequency of sound waves that male mosquitoes do, fooling female mosquitoes into staying away because they mistakenly think that male mosquitoes are near.

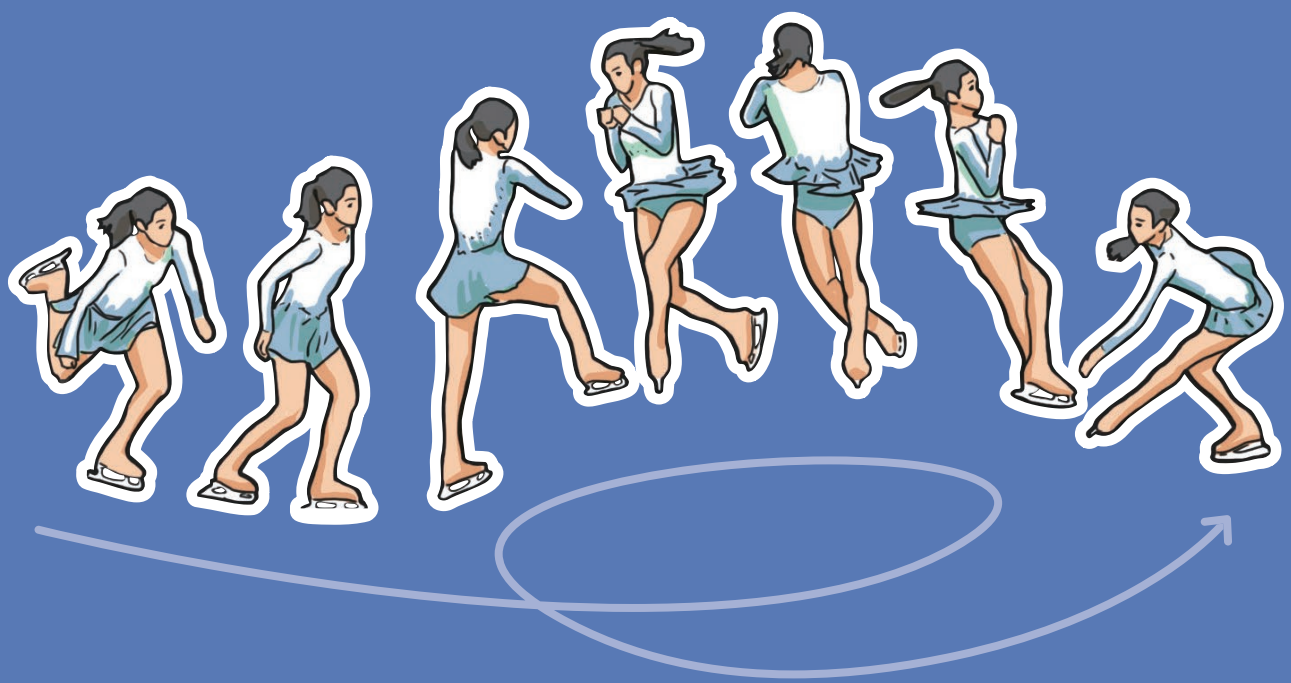
PART 7
INERTIA AND INVENTION

“When I was no longer nervous, the ice rink became a new world.”
“After watching footage of Michelle Kwon, I used the living room as an ice rink to skate all over.”

Yuna Kim, Olympic champion skater in 2009 and 2013, wrote the above as part of her journal.

Yuna Kim has been crowned “Queen of the Ice Rink,” and she is an athlete who can jump high and perform amazing feats in mid-air. Her specialty is the Triple Lutz, a move in which she does three full 360° turns before her skates return to the ice.

How can Yuna Kim accomplish such impressive feats?



Let’s look into inventions
that take advantage of the
laws of inertia

PREVIEW

AMUSEMENT PARK RIDES THAT USE THE LAW OF INERTIA

Let's look at the most typical invention that uses the law of inertia—the pirate ship ride.

WHY IS THE PIRATE SHIP RIDE SO THRILLING?

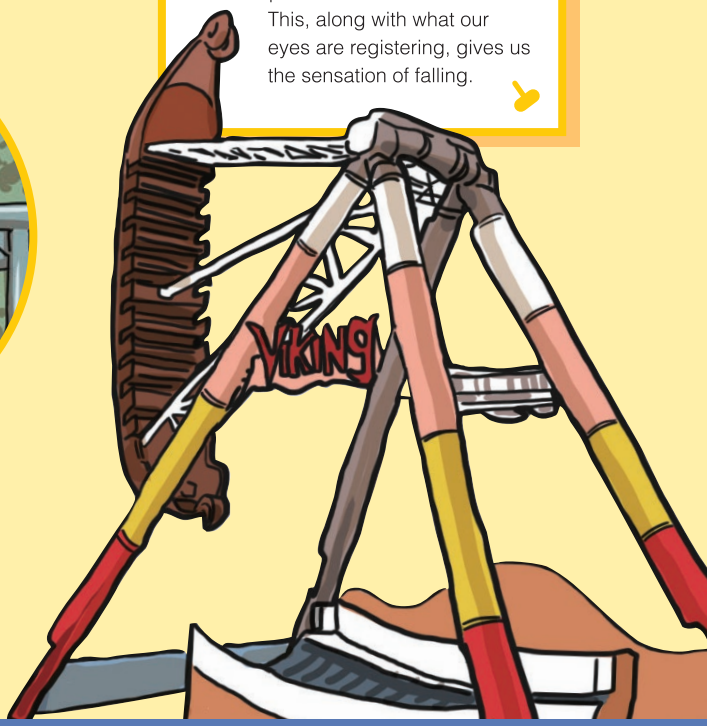
The three semicircular canals in our ears are filled with liquid. While these canals shift according to our movements, the inner liquids remain still. This is how we sense rotations. Likewise, on rides such as the pirate ship, we can feel the incline when the boat swings up thanks to the liquid in our ears. When the ride swings back downward, the liquid in our ears moves up due to the law of inertia. This, along with what our eyes are registering, gives us the sensation of falling.

ROLLER COASTER

When the roller coaster picks up speed, passengers' bodies are pushed back from inertia. Because of this, the speed and thrill of the ride are amplified.

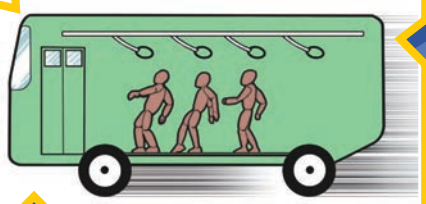
FAST BOAT RIDE

When the boat races downward, inertia causes our hair to rise and the water to splash. This makes the ride more thrilling.

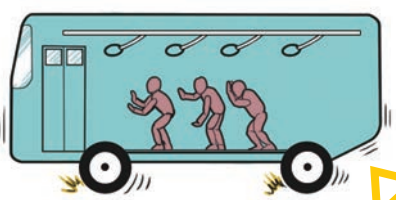


THIS IS WHAT HAPPENS TO PEOPLE INSIDE A BUS WHENEVER IT STARTS AND STOPS MOVING.

When the bus starts moving



When the bus stops moving



Can you think of more examples of incidents like this?

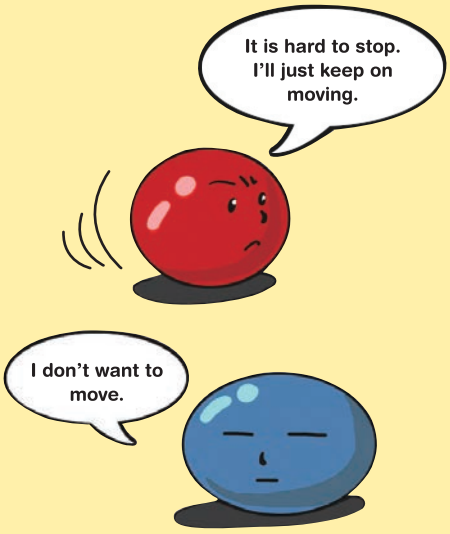
THE LAW OF INERTIA

EXPLORING PRINCIPLE 1

PUSHING AND STOPPING A WAGON WITH A WOODEN BLOCK ON TOP.

01 The wooden block will fall backward when the wagon is suddenly pushed forward.

02 The wooden block will fall forward when the moving wagon is suddenly stopped.



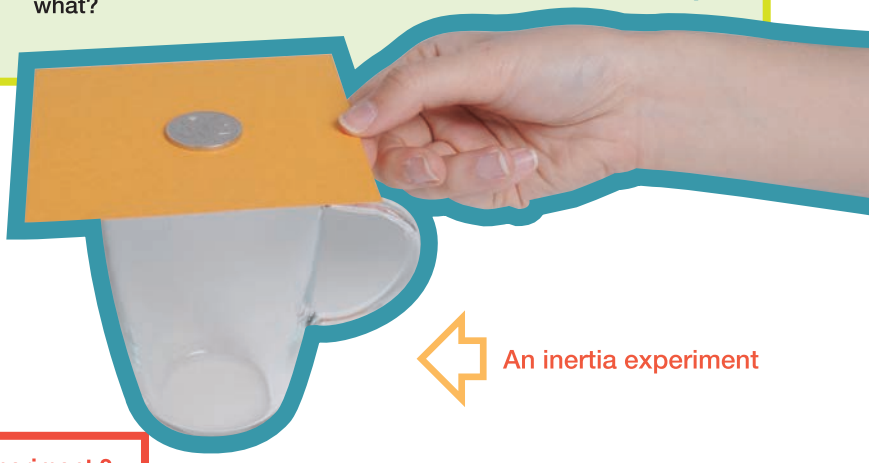
The Law of Inertia

An object at rest will remain at rest, whereas an object in motion will stay in motion, while maintaining its speed and direction.This principle is called inertia.

Experiment 1

What will happen to the coin in the following experiment?

1: When the card is pulled away slowly, the coin will do what?
2: When the card is pulled away quickly, the coin will do what?



An inertia experiment

Experiment 2

Different results from raw and boiled eggs

Method of experimentation

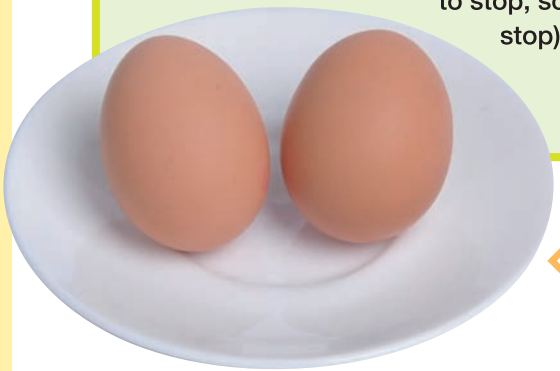
Take a raw egg and a boiled egg and spin them both around. Touch the eggs to halt their spin, then let them go again.

1: a raw egg

Due to the nature of liquids, the egg white and yolk will tend to keep turning, so a raw egg will (turn, stop).

2: a boiled egg

Due to the nature of solids, the egg white and yolk will tend to stop, so a boiled egg will (turn, stop).



An inertia experiment

EXPLORING PRINCIPLE 2

MAKE A "ROLLING FRAME"

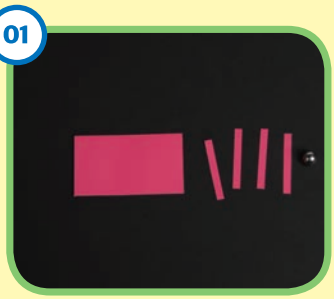
Make a rolling frame using the principle of inertia!

PREPARATION MATERIALS

Thick paper (or Supplement 08), marbles, scissors, adhesive tape

How to make it

DVD 01



01 Get Supplement 08 and some marbles ready.

02 Roll up the paper using a thick marker or pen.

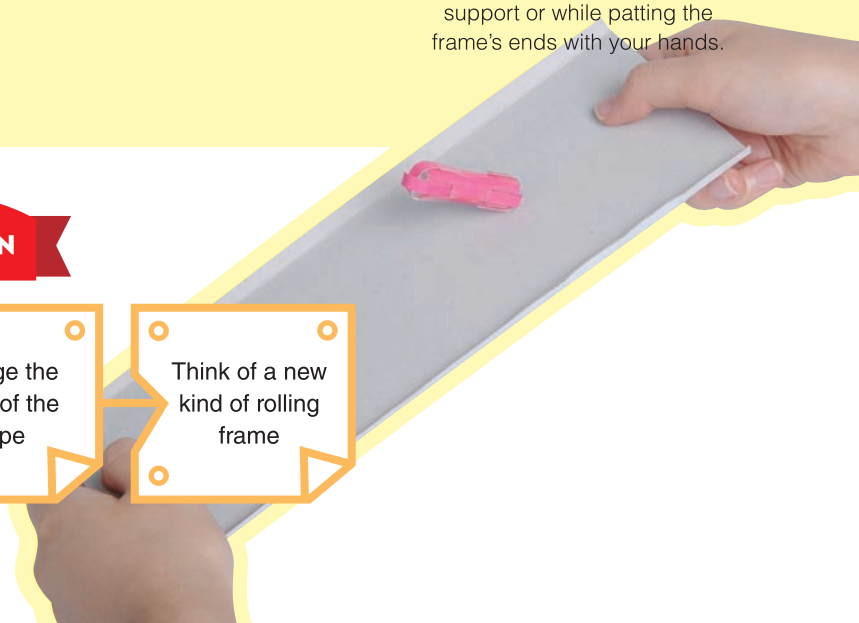
03 Tape up the rolled paper.

04 At one end of the paper, which is now rolled into a cylinder, attach two curved paper straps.

05 Make a cross out of the two paper straps and paste them on top of the cylinder in the form of a dome.

06 Put the marble inside the rolling frame and repeat Step 5 for the other end of the cylinder.

07 Put the rolling frame on a book or a large plate. Then observe its movement while tilting its support or while patting the frame's ends with your hands.



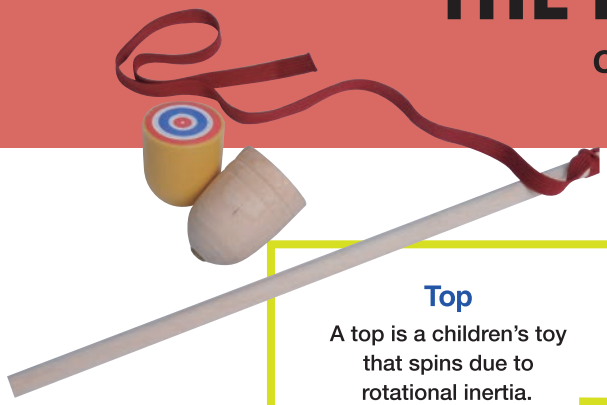
NEWER AND MORE FUN

- Change the length of the rolling frame
- Change the weight of the marble
- Change the angle of the slope
- Think of a new kind of rolling frame

INVENTIONS THAT USE THE LAW OF INERTIA

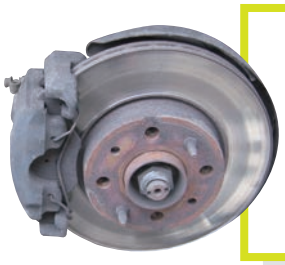
EXPLORING INVENTIONS

Check out these everyday inventions that use the law of inertia.



Top

A top is a children's toy that spins due to rotational inertia.



Brakes for automobiles

Brakes allow cars to stop when they need to. Without them, accidents would occur because of the inertia of motion.

Dehydrator

The wash tray spins and dries the clothes inside through rotational inertia.

Bus handle

Bus handles keep people from falling over from inertia whenever a bus starts or stops moving.

Explain the relationship between the following inventions and inertia.

▲ Bicycle

▲ Airbag

▲ Vegetable Dehydrator

▲ Seatbelt

INVENTION EXPERIMENT

DESIGN A NEW INVENTION!

Make a paper top using the principle of inertia.

PREPARATION MATERIALS

pencils, Supplement 09, adhesive tape

HOW TO MAKE

01

Cut out a circle from a piece of cardboard. (or use Supplement 09.)

02

Make a tiny hole in the center, then put a stick through it and secure it with adhesive tape.

Exploring Activity

Study the structure of the top and the principle of its spin.

★ A top is composed of two parts: the central axis and the body.

★ The axis and the body spin together.

★ _____changes its rotational energy.

Design a new top using the same methods of invention as in the example.

Method 1

Addition

By adding quantity, or application, characteristics, come up with a more effective idea through addition.

e.g. What if we add another body?
⇨ a two-story top?

e.g. What if we add light?
⇨ a luminous top?

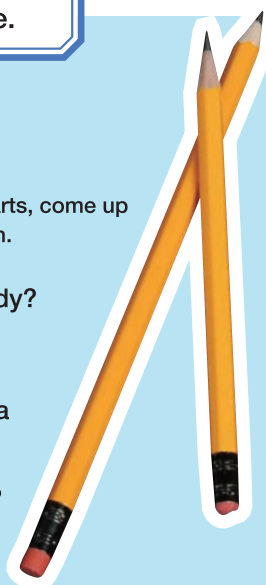
Method 2

Subtraction

By subtracting quantity, characteristics, or parts, come up with a more effective idea through subtraction.

e.g. What if we make holes on the body?
⇨ a perforated top?

e.g. What if we get rid of the body or a part of its axis?
⇨ Can a top spin without its tip?

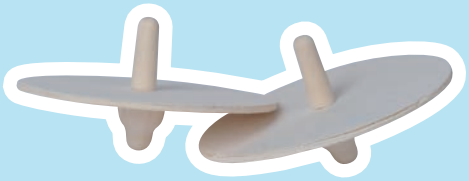


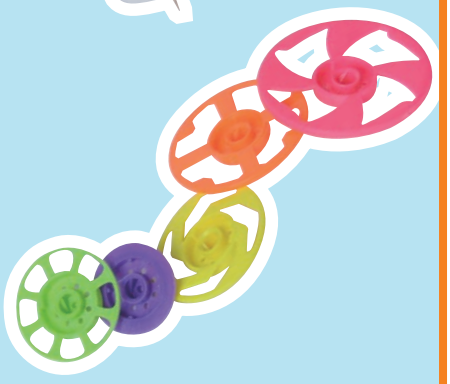
Freely express your ideas via the invention method.

add

subtract

TIP: Look at these other types of tops!





Draw the selected idea

Combination	01	
	02	
Removal	01	
	02	
Maximization/ Minimization	01	
	02	
Adaptation	01	
	02	
Modification	01	
	02	
Alternate usage	01	
	02	
Inversion	01	
	02	
Substitution of materials	01	
	02	
Recycling	01	
	02	
Imitating nature	01	
	02	

STORY OF INERTIA

THERE GOES INERTIA, CATCH IT!

Read the story and put on a fun, creative show about inertia with your friends.

There once was a king named “Mai Wey” (pronounced “My Way”) in a small land far away. He thoroughly liked to change everything to the way he wanted. One day, as he ran to the new playground he had created, he fell down flat on his face while trying to stop himself from running. At that moment, he pondered the question, “Who pushed me?!”

Without any answers to why that had occurred, he made his way to the swing and began to play on it. As he later jumped off and stood there in pride, the swing came up and hit him in the back of the head. Again, he wondered, “Who dared to hit my head?!”

Furious, he marched back to his palace and began to yell at everyone.
Then, a servant named Mr. Pretentious stepped out to comment on such “random” occurrences, “Inertia – that is what hurt you.”

The king, infuriated, ordered his underlings to catch this thing known as “inertia.” He wanted all inertia within the country eradicated. It come to the point where he hung signs everywhere stating that anyone who was involved with inertia would pay for it with their lives.

Kim, Youngsoo, <There Goes Inertia, Catch It!>

What do we have to prepare before putting on a show about this story?

- Script
-
-
-
-
-
-
-
-

PREPARE AND PUT ON A SHOW WITH YOUR FRIENDS. THEN EVALUATE EACH OTHER’S PERFORMANCES.

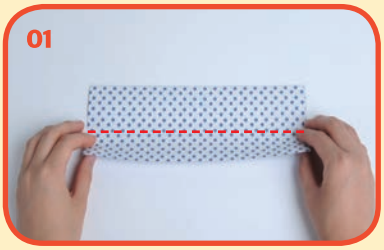
Write an invention journal to describe your invention experiences.

Title

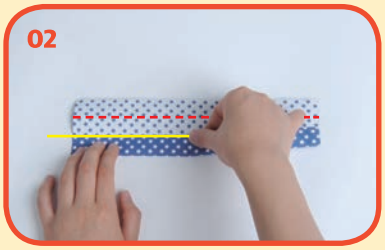
MAKE A PAPER BOOMERANG!

Make your own paper boomerang using Supplement 10!

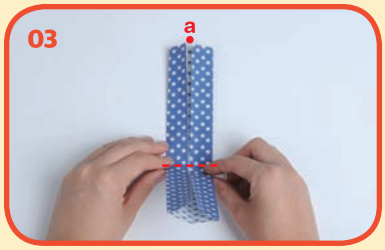
DVD 02



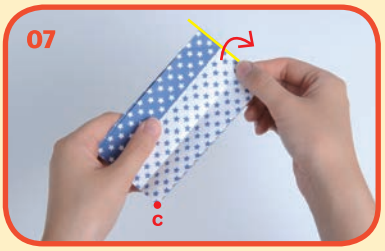
Cut Supplement 10 in half. Fold one section in half, then unfold it.



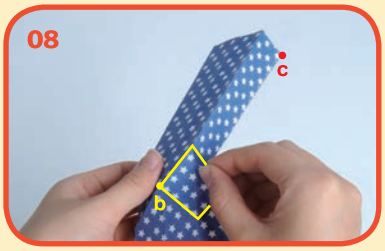
Fold both the top and bottom in halves according to the guideline.



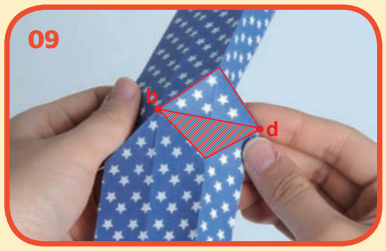
Orient it vertically, then fold it in half again. (Locate Dot A!)



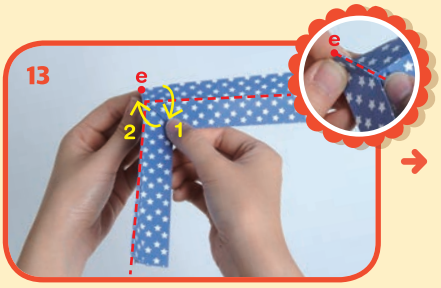
Fold it in half, then spread it out again just like in Step 6. Then turn it over. (Locate Dot C!)



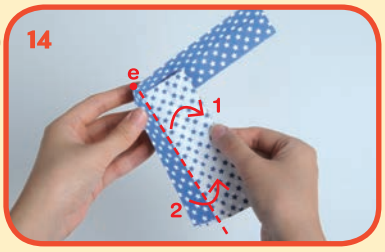
Create the outline of a rectangle while folding along the guideline. (Locate Dot B and Dot C!)



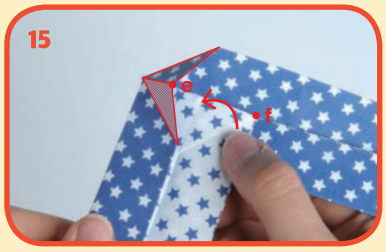
Make sure you see a rhombus with a recessed center just like in the picture, then flip it over. (Locate Dot B and Dot D!)



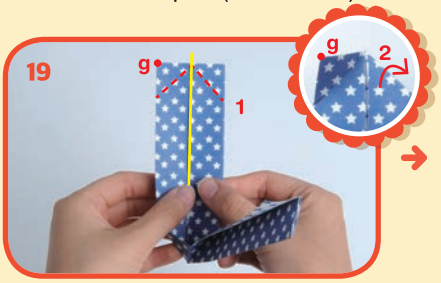
1. Fold along the guideline while holding Dot E. Make sure you have a line that is a valley fold, just like the picture in the circle.
2. Go back to Step 12. (Locate Dot E!)



1. Spread the floor side of the bottom outward.
2. Fold the bottom along the guideline. (Locate Dot E!)

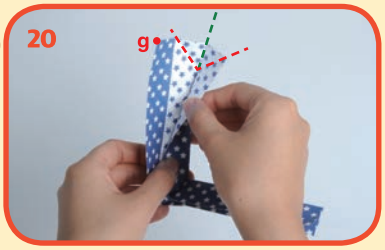


You should see the two triangles shown in the picture when you complete Step 14. Put Dot F into the space under them. (Locate Dot E and Dot F!)

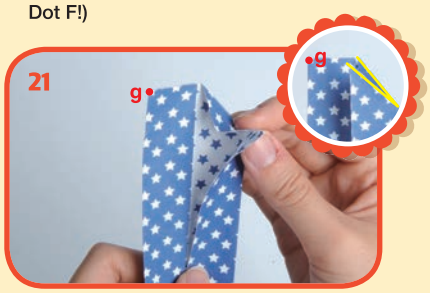


You can see the figure in the picture when you spread the side that's folded in half.

1. Fold both upper edges till they meet the guideline.
2. Fold one corner outward and then spread it out again. (Locate Dot G!)



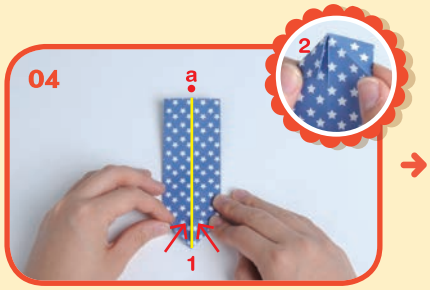
Spread out the side folded in half and you will see the same figure as in the picture. Fold along the line. (Locate Dot G!)



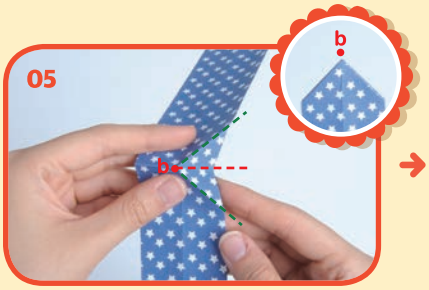
You should see the same figure as in the picture when you finish Step 20. You will have a space between the two guidelines, just like the picture in the circle. (Locate Dot G!)

A boomerang thrown into the sky will return to you, spinning round.
Its rotational inertia enabled this return.

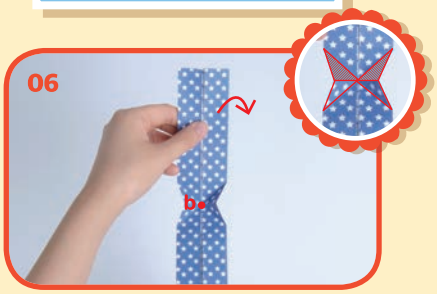
Valley Fold
Mountain Fold
Guideline



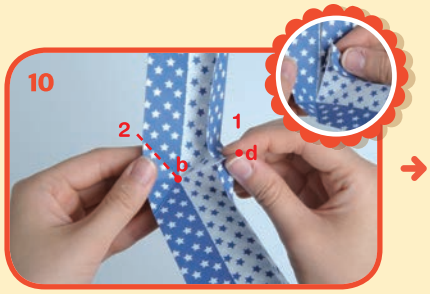
1. Fold both ends of the bottom corners till they meet the guideline. (Locate Dot A!)
2. Fold to the other side.



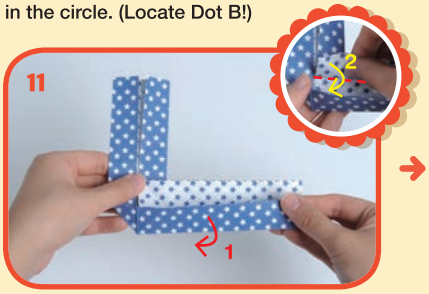
Unfold the lines from Step 3 and 4, then flip it over. By folding the three lines intersecting Dot B along the guidelines, you can get a sharp tip just as in the picture in the circle. (Locate Dot B!)



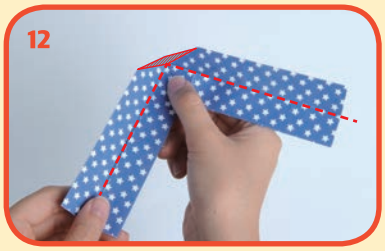
Spread out every line you folded in Step 5. Make sure you can see the ribbon (Note the picture in the circle). Then spread out the right side. (Mind Dot B!)



1. Fold until Dot D meets the upper side.
2. Fold the left side along the guideline (Locate Dot B and Dot D!)

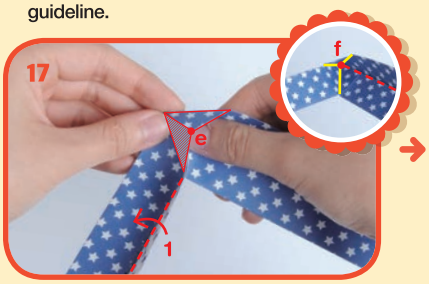


You can see a flat shape like “L” when you finish Step 10 properly.
1. Spread the blue side at the bottom outward.
2. Fold the white side on top along the guideline.

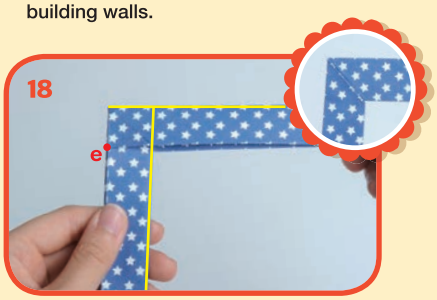


You can see a small triangle if you complete Step 11 properly. Then fold up the three lines as if you were building walls.

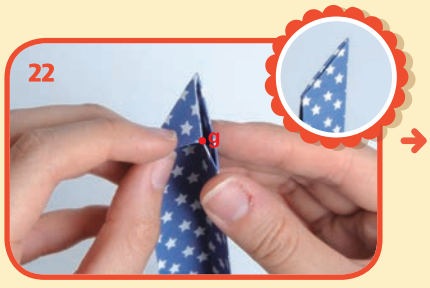
You can see the same figure as in the picture when Step 15 is properly completed. (Locate Dot E and Dot F!)



1. Fold up along the guideline while pushing Dot F to the end with your thumb.
2. Fold along the guideline after making sure Dot F reaches the deep end. (Locate Dot E and Dot F!)



After completing Step 17, your object should match the picture. Press extremely hard when folding the guideline. The center of the flipside should be the same as the picture in the circle. (Locate Dot E!)



Hold Dot G and push it into the space you made in Step 21. The end of the paper will look like the picture in the circle if it’s folded properly. (Locate Dot G!)

Fold the other side just like you did in Steps 19-22, and you’re done!

TRY THROWING THE COMPLETED PAPER BOOMERANG!

Hold the center of boomerang with your thumb and forefinger. Then, rear back and throw it with all your strength. The boomerang will do a better job of coming back to you if you recoil your wrist.

CREATIVE PROBLEM-SOLVING PROJECT

TOPIC 1

MAKE A CUP STAND ON ITS HANDLE!

When you put down your toothbrush cup after brushing your teeth, the remaining water stays inside the cup.
This increases the possibility of bacteria propagating. Furthermore, bacteria might multiply rapidly inside the cup since bathrooms are usually not ventilated properly. However, for hygienic reasons, we cannot place the cup upside down, since the rim would come in contact with dirty surfaces. Wouldn't it be great if we could use a toothbrush cup that allowed residue to flow out after usage, without the rim touching any unclean surfaces?

This project allows you to make a convenient and hygienic toothbrush cup. Check out the problem and come up with ideas for completing the mission.

A PROJECT MISSION

1. Mission

Make a cup by transforming the shape of the handle according to the specification below.

A hygienic cup that lets water inside flow out after use without having its rim touch other surfaces

2. Conditions of the mission

- ★ The residue inside the cup must flow out completely.
- ★ The rim of the cup must not touch other surfaces.
- ★ The handle must be convenient to use.
- ★ The cup must look appealing.

PREPARATION MATERIALS

Materials

1 paper or plastic cup (or Supplement 07), various materials to make a handle (straws, sticks, etc.), 5 chunks of clay (about 5x3cm each), cardboard

Tools

scissors, a ruler, adhesive tape

Standards for performance evaluation

Results of the idea

- ★ Degree of water flow (20)
- ★ Hygienic structure (20)
- ★ Convenience of Use (10)
- ★ Aesthetic excellence (10)

Creativity of the Idea

Is the idea original? (30)

Presentation Skills

Was the idea explained effectively? (10)

MISSION ACTIVITY B

1. Come up with a new idea for a toothbrush cup!

Concept perspective 1 – Find its center of gravity!

▶ Look at the shape of a common cup handle.

Where is the handle usually located?

What is the function of the handle?

▶ Place the cup upside down!

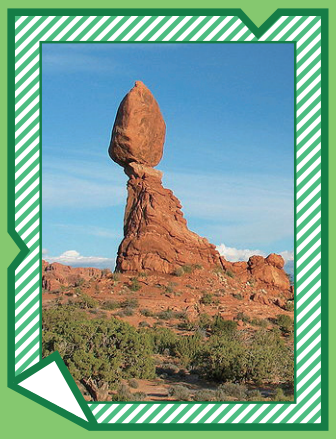
What's the problem?

Let's discuss what to consider in order to prevent the rim of the cup from touching other surfaces letting the residue flow out.

- How can we allow the water inside to flow out of the cup after using it?
- How can we prevent the rim of the cup from touching other surfaces?

HOLD ON!

WHAT ARE THE EFFECTS OF THESE UTENSILS?



HOW CAN THE ROCK IN THE PICTURE REMAIN UPRIGHT?

WHAT WOULD BE THE KEY PRINCIPLE WHEN INVENTING A NEW TOOTHBRUSH CUP?

CONCEPT PERSPECTIVE 2
THINK ABOUT DESIGN!

VARIOUSLY-SHAPED HANDLES

Look through the variously-shaped cup handles below.

Perspectives

- Does a handle's location contribute to its use?
- Is the shape of the handle in harmony with the cup?

NEW IDEAS

Add new functions

New design and features

▶ Explain the idea you came up with!

PROJECT RESOLUTION AND EVALUATION C

1. IDEA SKETCH

Draw a blueprint based on your new idea, and give a simple explanation
(Think about how to use the provided materials).

Blueprint

Explanation

2. MAKE A MODEL!

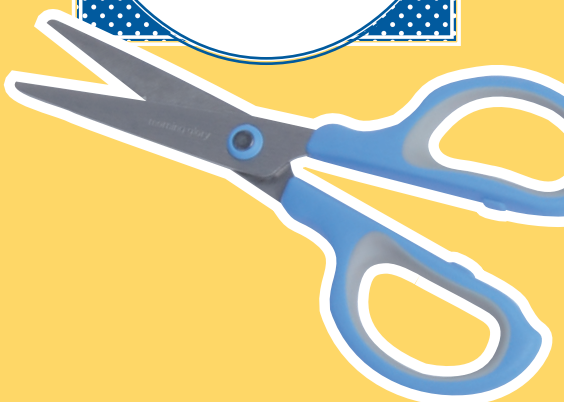
Build a model using the provided materials.

Materials

1 paper or plastic cup (or supplement 07), various materials to make a handle (straws, sticks, etc.), 5 chunks of clay (about 5x3 cm each), cardboard

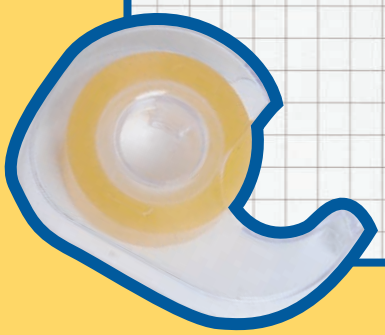
Tools

scissors, a ruler, adhesive tape



3. ORAL PRESENTATION

Present the result, focusing on its new functions and creative design.



D WRAP UP THE PROJECT

1. Evaluate the project

Wrap up the project by evaluating the work according to the score chart.

Evaluation factors		Score	Score range	Evaluation
Effectiveness of Idea (60)	Degree of Water Flow	20	20 (excellent), 17 (acceptable), 15 (requires improvement)	
	Hygienic structure	20	20 (excellent), 17 (acceptable), 15 (requires improvement)	
	Convenience of Use	10	10 (excellent), 8 (acceptable), 6 (requires improvement)	
	Aesthetic excellence	10	10 (excellent), 8 (acceptable), 6 (requires improvement)	
Creativity of Idea (30)		30	30 (excellent), 25 (acceptable), 20 (requires improvement)	
Presentation Skill (10)		10	10 (excellent), 8 (acceptable), 6 (requires improvement)	

Conclude the activity

2. Apply and Develop the Project

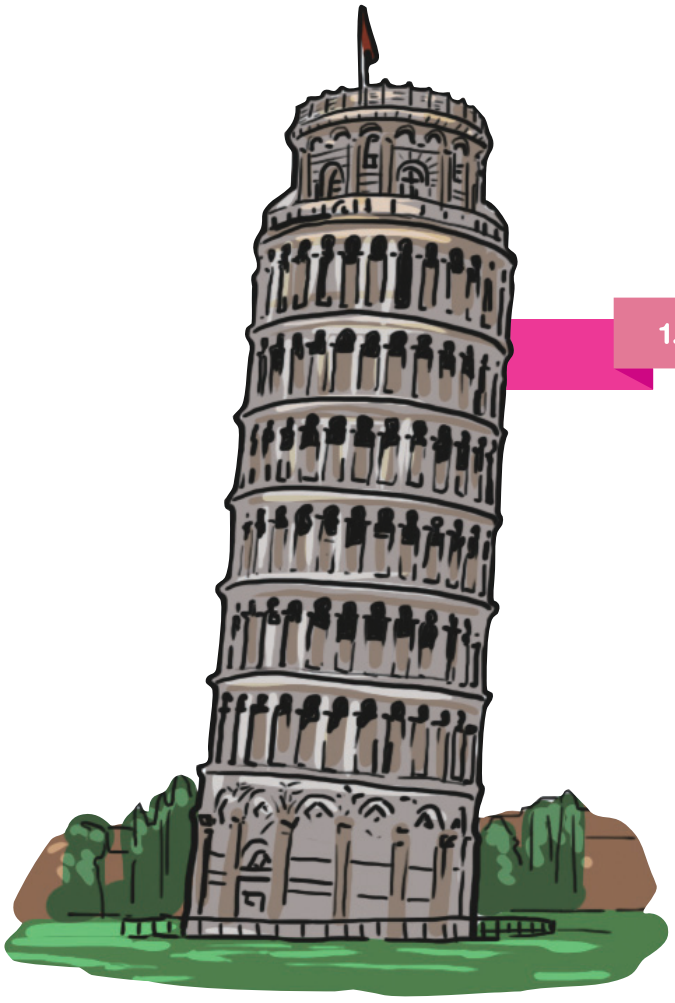
Apply the knowledge, methods, and ideas gained from this activity to other objects.

What is center of gravity?

It's the point where an object can balance itself horizontally.
We can support the entire object by holding up its center of gravity.
If an object's center of gravity is close to the top, it will be unstable and topple easily. However, objects remain stable and don't topple easily when their center of gravity is close the bottom.

OTHER RELATED RESEARCH

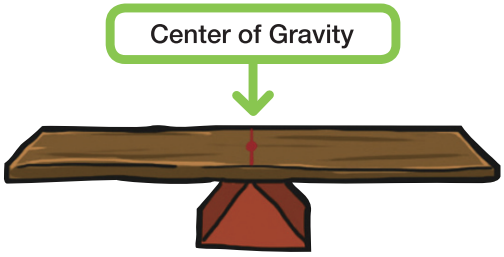
E

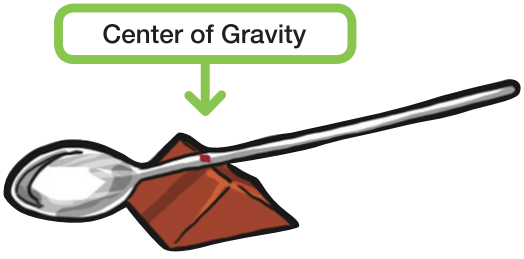


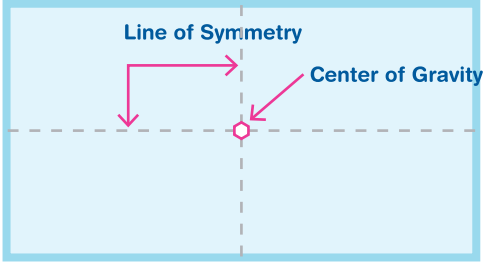
1. Why doesn't the Leaning Tower of Pisa fall?

The Leaning Tower of Pisa has been gradually tilting, even after several repairs, since it was first built in 1372. It now leans at an angle of about 5.5° from the ground. The reason why the Leaning Tower of Pisa doesn't fall despite being tilted is because of its center of gravity. The tower's center of gravity is at its bottom. This supports the entire building and allows it to maintain its stability even though its foundation is on an area of ground that is too soft on one side to properly support the structure's weight.

CENTER OF GRAVITY AND BALANCE





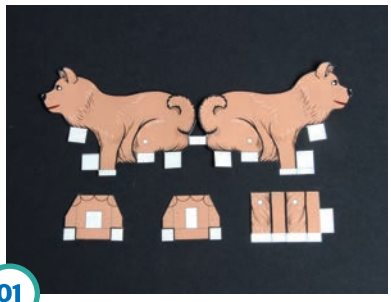


The center of gravity of a symmetrical object is the point where the lines of symmetry intersect. The center of gravity for symmetrical objects like paper and rulers can be found by drawing lines of symmetry.

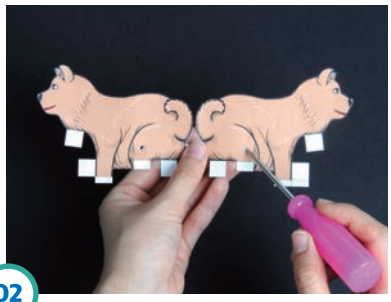
DVD 03

2. Other experiments : Make a toddle dog!

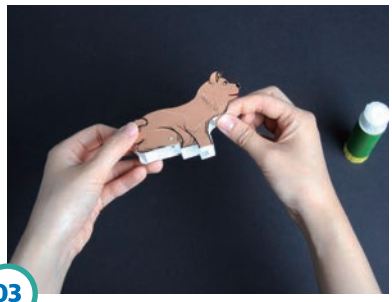
Preparation Materials: Supplement 11, scissors, a cutter, glue or adhesive tape, a stick, and a paperclip



01 Tear off the body and legs of the toddle dog from Supplement 11.

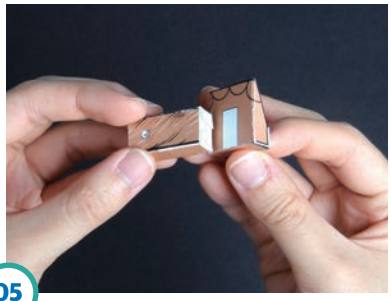


02 Make a hole in the center of the body.

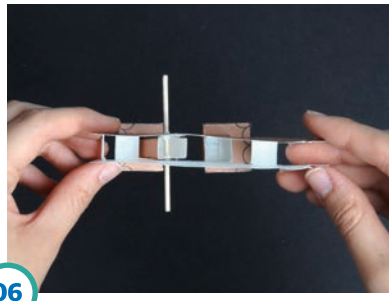


03 Attach the body with glue.

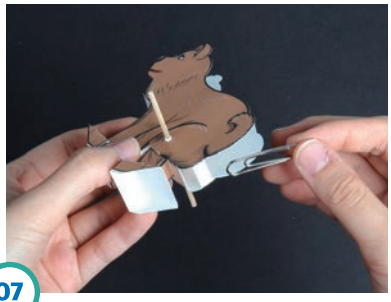
04 Add the front legs.



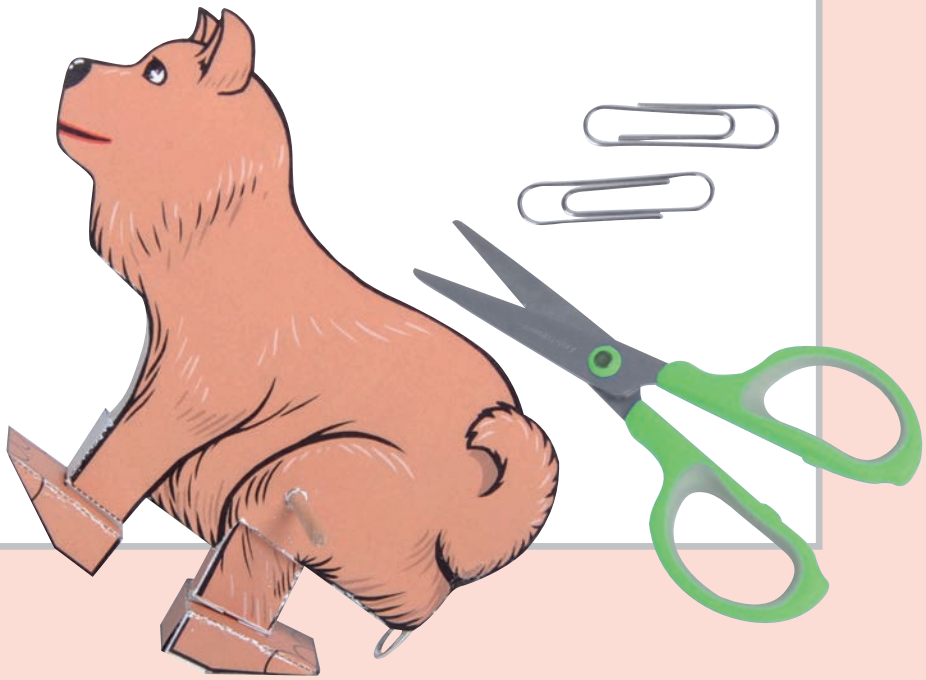
05 Add the rear legs.



06 Connect the body and legs using the stick.



07 Put a paperclip on the tail of the dog to finish it!



Press down slightly on the toddle dog's tail. How does it move?

How can the toddle dog move down a slope without sliding?

THE SECRET OF THE TODDLE DOG

You can see how the dog's center of gravity changes by watching the way it moves, which is similar to how a bird walks. They both waddle by shaking their heads back and forth. Shaking its head helps it move its center of gravity forward.

The dog moves forward when it's on a slope because gravity pulls its center of gravity forward. However, it can stop without falling over because the friction of the floor stops it when its center of gravity moves back toward its heavy tail. Then, the legs of the dog move back and forth, and this is how the toddle dog moves. The paperclip on the tail controls the dog's center of gravity.

If your toddle dog doesn't move forward, you can adjust the position of the paperclip on the tail to better control its center of gravity or the angle of incline.

THE BEST INVENTION IN THE WORLD

Pikadu is a little boy living in a small town in Africa. He used to walk for long periods of time holding a small container under the blazing sun.
The only river he can get water from nearby is a few kilometers away from his home. Going back and forth was a daily mission, and with a full container, it was simply too much of a physical strain on this poor little boy.
The precious water would spill out of the container as he waddled and struggled with the weight of it all.
One day, something amazing changed his life. He was introduced to Q-drum, a container designed a funny shape. Like a donut, it was round and had a hole in its center, and it moved in the same way that you would roll a wheel, towing it via an attached rope.
Thanks to this invention, now Pikadu does not have to carry a heavy container filled with water in his hands or put it on his head. He won't lose any drops of the precious water and he can run like the wind, while the Q-drum follows behind. The container is not a burden anymore – it is lightweight.
The inventor of the Q-drum was Piet Hendrikse from the Republic of South Africa.
His sympathy for the women and children carrying heavy containers throughout theday just to get water to drink inspired him to work hard to offer them a better life for them.
Thus, the Q-Drum was invented.

INVENTION FOR A BETTER LIFE

MONEY MAKER PUMP

This pump was invented for poor farmers in Africa.
It functions when a person steps down on it. This simple, easy movement draws up the water flowing deep underground.
People in Africa who lacked the necessary water for farming can now easily get it using this pump.
The poor farmers in Africa can now make a living thanks to this pump.

INVENTING EQUAL OPPORTUNITIES

A 100 DOLLAR LAPTOP XO

This laptop was invented for the education of students in needy countries.
It costs only 100 dollars, so even students without lots of money can afford it.
It has a pedal that the user can turn to charge the laptop.
Thanks to this laptop, many students in the world have been given an equal opportunity to learn and study.

INVENTING TO SAVE THE ENVIRONMENT

G-SAVER HEATING AID

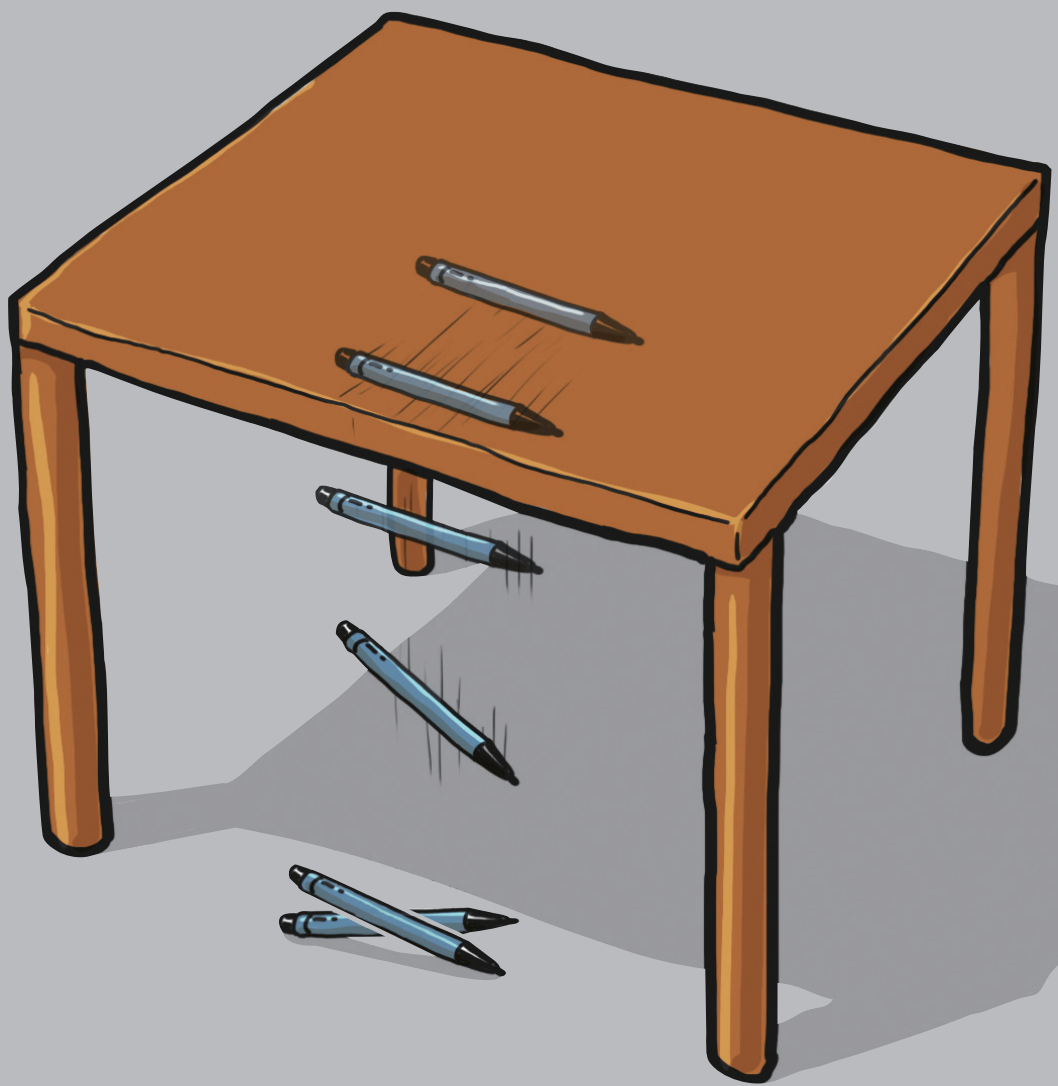
G-saver was invented for Mongolians who suffered from exhaust gas given off by fossil fuels.
This heating aid conserves heat and can keep a room warm for a long time using just a small amount of coal. The less fossil fuel we burn, the less exhaust gas there will be.
We will not only be able to live in a better and healthier environment but we can also reduce atmospheric pollution by using this heating aid.

CREATIVE PROBLEM-SOLVING PROJECT

TOPIC 2

GRAB THE ROLLING OBJECT!

Many school supplies, such as pencils and glue sticks, are round. They often roll around and even fall from desks. When they fall, the noise can be distracting. How can we prevent round objects from rolling?



Through this project, we can keep school supplies from rolling around.
Check out the problem and come up with ideas for completing the mission!

A PROJECT MISSION

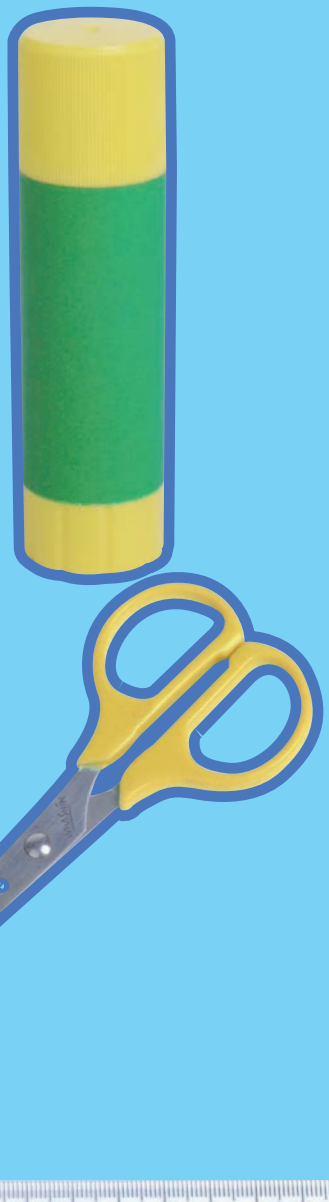
1. MISSION

Through this project, we can keep school supplies from rolling around.
Check out the problem and come up with ideas for completing the mission!

Using the provided materials, fashion a glue stick that won't roll around.

2 Conditions of the mission

- It must be easy to set the glue stick down on the surface of a desk.
- The glue stick must not roll even it falls over.
- The glue must be easy to use.
- It has to look appealing.



3 Preparation materials

Material

1 glue stick, 2 rubber bands, 2 paperclips, 2 kinds of straws (bendy/straight), 2 paper cups, 2 flat wooden sticks, 4 thumbtacks

Tools

1 ruler, scissors, and glue stick per team

4 Standards for performance evaluation

The results of the idea

- ★ How well the glue stands on a flat table (20)
- ★ How well the design prevents the glue from rolling (20)
- ★ Ease of use (10)
- ★ Aesthetic excellence (10)

Creativity of Idea

★ Is the idea original? (30)

Presentation Skills

★ Was the idea clearly explained? (10)

PROJECT MISSION ACTIVITY B

Concept perspective 1
Why does it roll?

Roll the glue and find out why it rolls.

1. COME UP WITH AN IDEA FOR A NEW GLUE STICK!

Shape

a cylindrical pillar

Why does it roll?

Pillar-shaped objects roll easily due to the law of inertia.

How can we design a glue stick that doesn't roll around?

Concept perspective 2
Stop the inertia of rolling!

Experiment on the following activities and solve the problem by stopping the inertia of an object's rolling motion!

Preparation Materials

A cup without a handle, a cup with a handle, a pen with a clip, a pen with part of it made of rubber, a round pencil case made of fabric or vinyl, other round things

Activity 1	Roll!
Activity 2	Observe and take notes to find out the causes
Activity 3	Write down anything hat might be helpful for completing the mission

ROLL A CUP WITHOUT A HANDLE!

How it rolls

Distinction

Problem Solving Point

ROLL A PLASTIC CUP WITH A HANDLE!

How it rolls

Distinction

Problem Solving Point

ROLL A FABRIC PENCIL CASE

How it rolls

Distinction

Problem Solving Point

ROLL A TUBE OF LIPSTICK

How it rolls

Distinction

Problem Solving Point

2. NEW IDEAS

New ideas

Effects of the ideas

▶ **Effectively explain the idea you came up with!**

PROJECT RESOLUTION AND EVALUATION

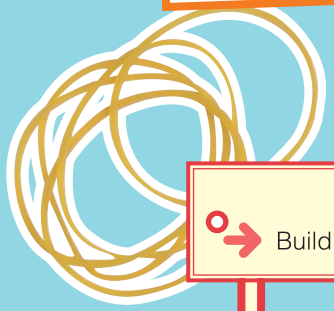
C

1. Idea sketch

Draw a blueprint to make a model of your new idea, then give a simple explanation. (Think about how to use the provided materials.)

Blueprint

Explanation



2. Make a model!

Build a model using the provided materials.

Materials

Glue stick, 2 rubber bands, 2 paperclips, 2 kinds of straws (straight/bendy), 1 paper cup, 2 flat woodensticks, 4 thumbtacks

Tool

rulers, scissors, glue stick

3. Oral presentation

Present the work, focusing on its new functions and creative design.

D WRAPPING UP THE PROJECT

1. EVALUATE THE PROJECT AND WRAP IT UP

Wrap up the project by evaluating the idea using the score chart.

Evaluation Factors	Score	Score range	Evaluation
Capability to stand on a desk (20)	20	Capability to stand on a desk (20)	
Degree of Rolling (20)	20	20 (stops right away), 17 (rolls and stops), 14 (keeps rolling)	
Ease of Use (10)	10	10 (excellent), 8 (acceptable), 6 (requires improvement)	
Aesthetic excellence (10)	10	10 (excellent), 8 (acceptable), 6 (requires improvement)	
Creativity of Idea (30)	30	30 (excellent), 25 acceptable), 20 (requires improvement)	
Presentation Skill (10)	10	10 (excellent), 8 (acceptable), 6 (requires improvement)	

Conclude the activity

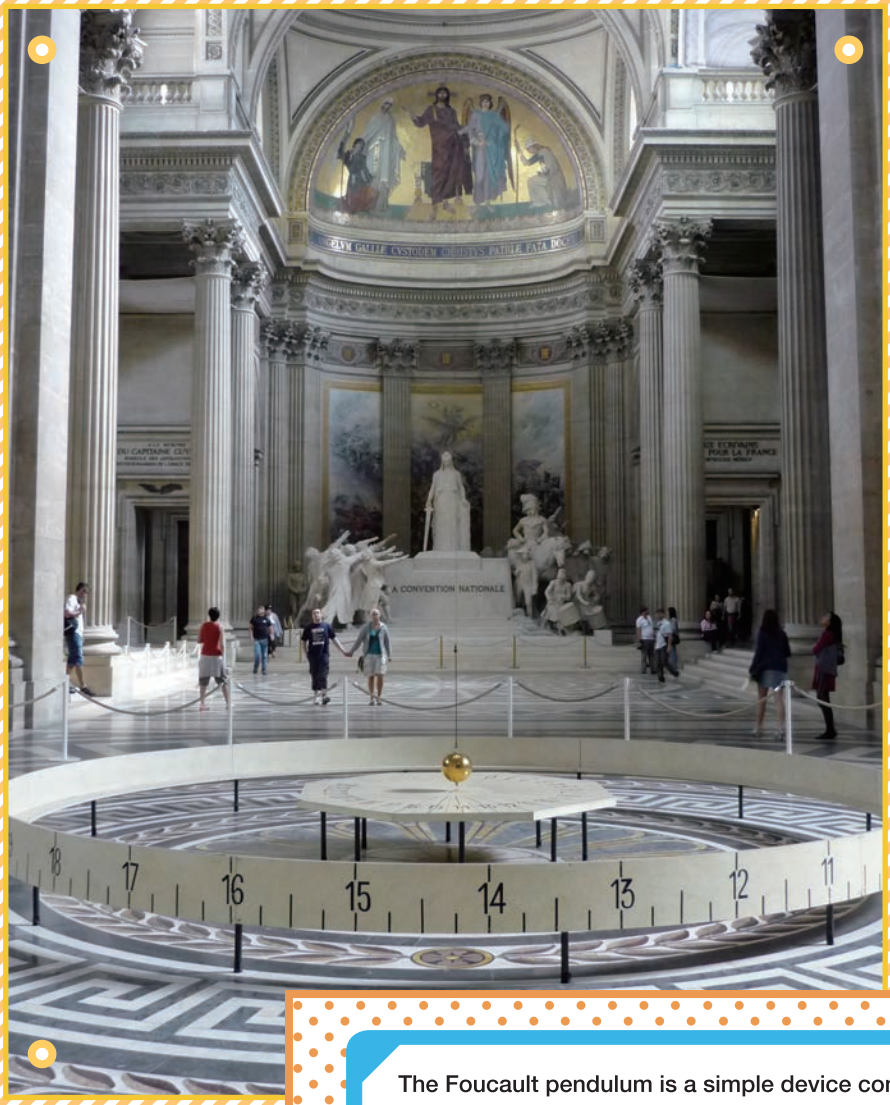
2. APPLY AND DEVELOP THE PROJECT

Apply the knowledge or ideas you gained from the activity to other objects.

What is inertia?

An object at rest tends to stay at rest, and an object in motion tends to stay in motion; this principle is called inertia.

OTHER RELATED RESEARCH E



HOW DOES THE FOUCAULT PENDULUM CONTINUE MOVING?

The Foucault pendulum is a simple device conceived as an experiment to demonstrate the rotation of the Earth. French physicist Jean Bernard Léon Foucault built this pendulum by suspending a 28kg brass-coated lead bob with a 67m long wire from the dome of the Panthéon in Paris in 1851. He used it to prove the rotation of the Earth, and he received the Copley Medal of the Royal Society, which is considered the Nobel Prize of physics, for his “very remarkable experimental researches” in 1855. The Foucault pendulum continues moving because of inertia.

ROLLING DOWN THE THREE YEAR HILL

A long time ago, there was an old woodcutter who lived in a small town.
Near that town was a big, high hill that was very difficult to climb. The villagers called it the "Three Year Hill" because of a legend that if a person fell and rolled down the hill, he would live for only three more years.
Unfortunately, the old woodcutter had to climb up this hill whenever he needed to chop logs from the trees and go to the market.

One day,
the old woodcutter was happily busy chopping trees in the deep forest.
However, as he made his way down the hill, the heavy load of logs on his back caused him to take a tumble.

"Oh No!"

He screamed as he tumbled down the Three Year Hill.

From that moment on, he couldn't sleep at nights or eat meals because of his worry of dying after three years.

"I am going to die in three years...how could that be..."

he murmured in the night.
Growing skinnier and more pale, he appeared as if he would pass away soon.
As the villagers looked on, they began to feel sorry for him; however, no one was able to find a way to help him.

That was, until one day, when the smartest boy in town came to visit him.

"Sir, I know how you can outlive the curse" he reached out. The old woodcutter, surprised, pleaded to know,

"The way to live longer? Please tell me!"

The smart boy smiled and responded,

"It is very simple. Roll down the Three Year Hill as many times as you want. Rolling once gives you only three years. However, if you roll twice, wouldn't that give you six years? Ten times would mean sixty years."

Realizing the boy could be right, the old woodcutter immediately rolled down the Three Year Hill from that day forward.

Over and over again, he rolled and tumbled.

Thanks to the smart boy's brilliant idea, the old woodcutter improved his health and soon recovered from his illness.

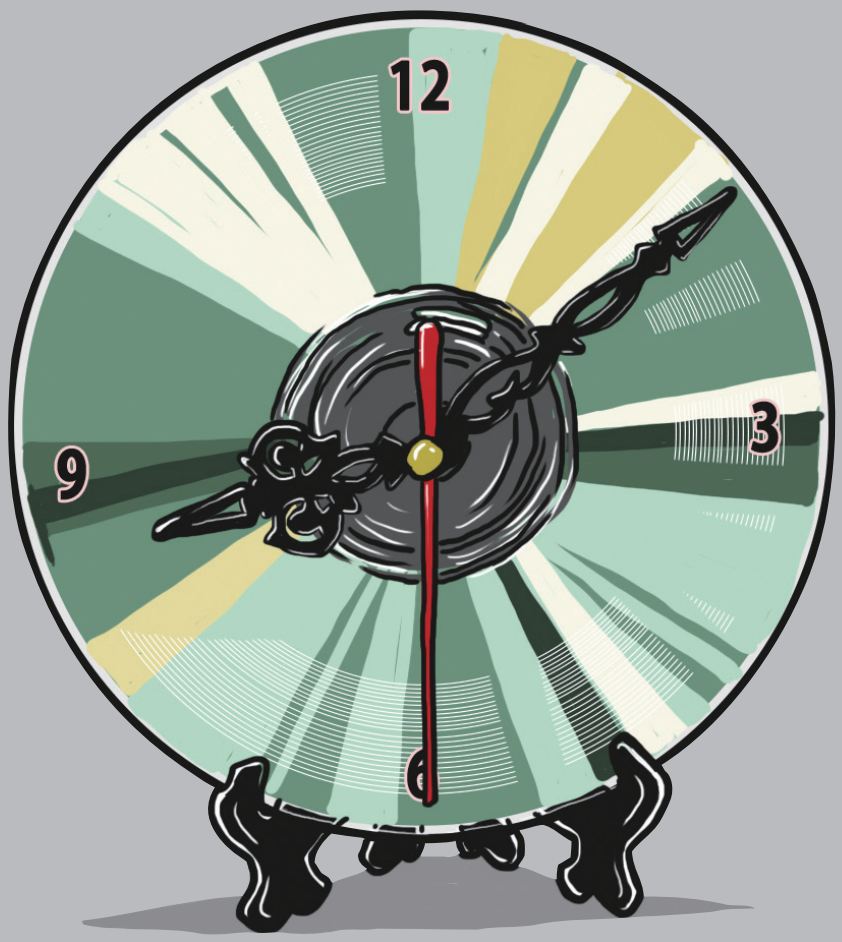
The apparent curse had vanished, and he lived for a long time there after.

CREATIVE PROBLEM-SOLVING PROJECT

TOPIC 3

CREATE A TOY OUT OF A DISCARDED CD!

The IFPI (International Federation of the Phonographic Industry) estimates that a CD (Compact Disc) is demanded throughout the world over 90 billion times per year. The main material used to make a CD is a type of plastic called PC (Polycarbonate). Greenpeace has warned that PC gives rise to an environmental hormone that attenuates reproductive and immune systems and elevates cancer rates. It is also said that PC worsens global warming and recent health problems by generating hazardous chemicals such as dioxin when it is burned.



Through this project, we will learn various ways
for utilizing discarded CDs, such as making toys out of them.
Let's check out the problem and come up with ideas
to complete the project!

A PROJECT MISSION

1. MISSION

Make a toy from an old CD and the materials provided.

2. MISSION PARAMETERS:

- Come up with various ideas for toys, such as ones that spin, roll, or glide.
- Compare the pros and cons of each idea to select the final one.
- The final idea should be accompanied by a blueprint and explanation. You should also evaluate the toy as you play with it.

3.PREPARATION MATERIALS

Materials: 4-5 discarded CDs, 2 kinds of straws (straight/bendy), 2 paper cups, 2 paperclips, 2 marbles, 2 balloons, 2 chopsticks, a 50cm rubber band, CD stickers and Supplement 12

Tool: Scissors, a 30cm ruler, a marker, and glue

4. STANDARDS FOR PERFORMANCE EVALUATION

The effect of the idea

Number of ideas (20)
Quality of the idea (20)
Completeness of the model (20)
Attractiveness (30)
Oral presentation: Clearly explained the idea (10)

PROJECT MISSION ACTIVITY B

1. TRANSFORMING MY FAVORITE TOY!

Brainstorming perspective 1 – New forms and methods of playing

Let's choose the most interesting or memorable toy from among all the ones we have played with!

Toy	Interesting aspects (related to its playing methods and characteristics)

Think about how you would like to reconfigure this toy by focusing on its forms and rules of play.

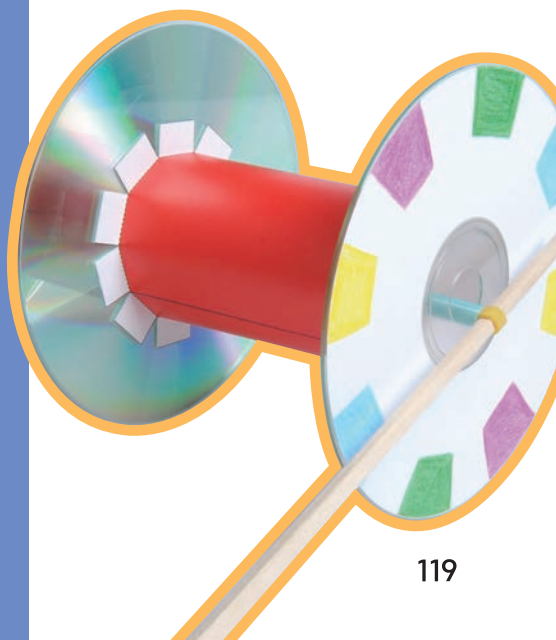
FORM

GAME RULES

2. USE SCIENTIFIC PRINCIPLES TO FASHION A NEW TOY FROM A DISCARDED CD.

Brainstorming perspective 2 – Use scientific principles to fashion a new toy from a discarded CD.

CD top (scientific principle: spin)	CD car (scientific principle: friction & elasticity)
What do we need to add in order to change a CD into a top?	What do we need to do in order to change a CD into a car?



DVD 04

LET'S MAKE A CD TOP AND A CD CAR TO PLAY WITH!

What kind of things do we need?

CD top a discarded CD, a CD label, markers, a marble, glue, adhesive tape, etc.

CD car Two CDs, Supplement 12, CD stickers, a straw, 2 chopsticks, a 15cm rubber band, adhesive tape, a glue gun, etc.

CD TOP

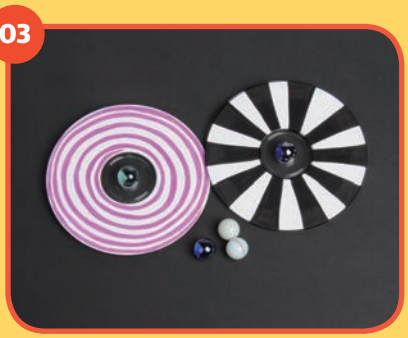
01

Put the label on the CD.

02

Decorate it.

03



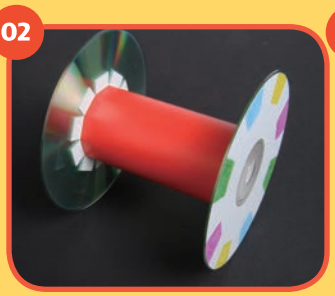
Glue a marble into the CD's hole using a glue gun.

CD CAR

01

Put the labels on the CDs and decorate them.

02

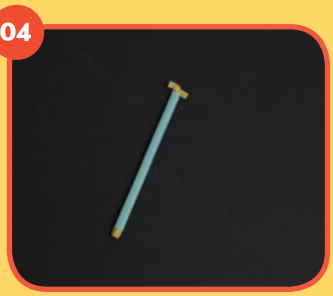


Roll up Supplement 12 and tape it together. Then cut both ends along the lines and adhere the CDs as shown in the picture.

03

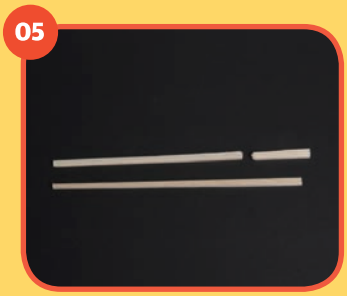
Cut a piece of straw the same length as the body of the CD car. Cut the rubber band and tie together both ends.

04



Put the rubber band into the straw.

05



Make one of the chopsticks shorter.

06

Insert the straw from Step 4 through the body of the CD car, and attach the long and short chopsticks on both sides. Then, attach only the side with the short chopstick by using adhesive tape.

07

Turn the long chopstick outward enough to wind the rubber band, then set the car on a flat surface.

CD top

CD car

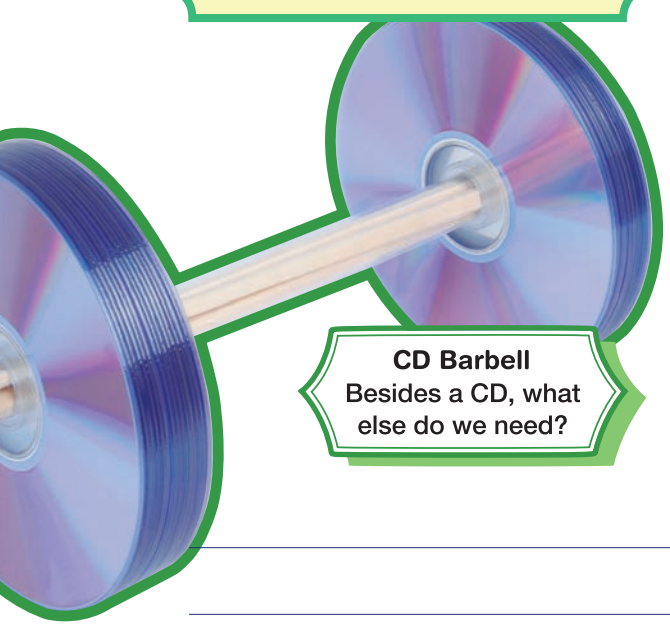
PLAY WITH YOUR CD TOP AND CAR, AND THINK ABOUT WHAT MAKES THEM INTERESTING.

CD Cell Phone Stand
Besides a CD what else do we need?

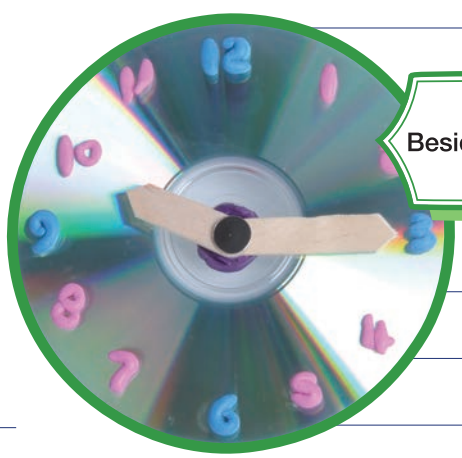
3. CHANGE YOUR IDEA INTO A PRODUCT YOU CAN USE IN DAILY LIFE!

Concept Perspective 3

Make a useful product from a CD.



CD Barbell
Besides a CD, what else do we need?



CD Clock
Besides a CD, what else do we need?

C PROJECT RESOLUTION AND EVALUATION

1. IDEA FOR CHANGING A CD INTO A TOY

Think about what characteristics a CD has and what we can make out of them. Write your ideas.

Characteristic	What can we do with it?
1	1
2	2
3	3
4	4
5	5

Think about how to play with a CD, and write down ideas for games and toys that incorporate CDs.

Idea	How to play with it	How to make it
1	(spin, glide, roll)	1
2	(spin, glide, roll)	2
3	(spin, glide, roll)	3

Choose the final idea

	Evaluation (Show it to your friend!)
Why ▸	☆☆☆☆☆

2. IDEA SKETCH

Make a blueprint for a model of your new idea, then give a simple explanation. (Think about how to use the provided materials.)

Blueprint

Explanation

3. MAKE A MODEL!

Build a model of your idea using the provided materials.

Materials: 4-5 discarded CDs, 2 kinds of straws (straight/bendy), 2 paper cups, 2 paperclips, 2 marbles, 2 balloons, a 50cm rubber band, 2 chopsticks, 2 pieces of A4 paper.

Tool: Scissors, 30cm ruler, marker, glue gun (1 for each group)

4. ORAL PRESENTATION

Play with the toy you designed and improve upon the idea.
Present your work while focusing on its new functions and creative design.

D WRAPPING UP THE PROJECT

1. EVALUATE THE PROJECT AND WRAP IT UP

Wrap up the project by evaluating your work using the score chart.

Evaluation Factors	Score	Score Ranges	Evaluation
Number of Ideas	20	20 (3 factors), 18 (2 factors), 16 (1 factor)	
Logical Thinking	20	20 (very logical), 17 (comparatively logical), 14 (general)	
Attractiveness	30	30 (5 stars★), 25 (4 stars★), 20 (Less than 3 stars★)	
Blueprint & Explanation	10	10 (great), 8 (general), 6 (requires more effort)	
Completeness	20	20 (great), 17 (general), 14(requires more effort)	

Conclude the activity

2. APPLY AND DEVELOP THE PROJECT

➔ Think about other recyclable materials to make toys with!

What

How

OTHER RELATED RESEARCH E

THE SCIENCE OF TOYS

Boomerang

1. A toy that spins

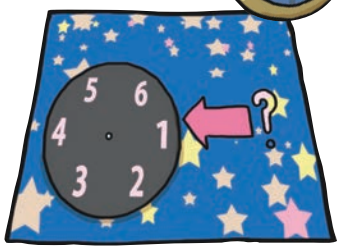
Helpful Knowledge: spinning

An object moves in a circle, in the same way that a car wheel or a top moves
★ Moves around its central axis
★ Moves in different directions

Top

Yo-yo

Tips → A CD is shaped in a circle. You can make it spin for a long time, stop it from spinning whenever you want, or watch the colors blend while it is spinning. It would be great to come up with a new game to play with a CD!



Roulette

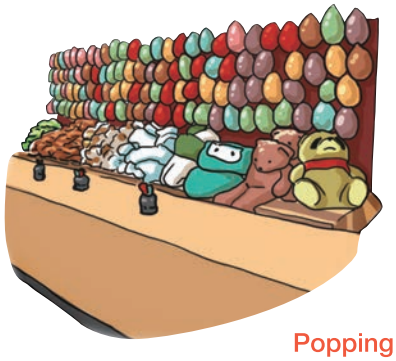
2. A toy that glides

Helpful Knowledge: gliding

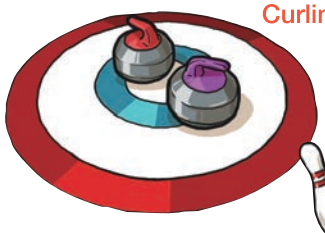
An object with wings glides in the air against the horizontal plane (water level). While gliding, it generates lift, which raises an object and thrusts, or pushes, the object forward.

Tips → Can we fly a CD? What do we need to do to make a trashed CD fly for a certain distance? It'd be helpful to think of possible structures to build in order to make toys like boomerangs or to play a fun game like popping balloons with darts.

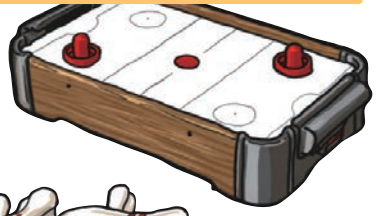
Glider



Popping balloons



Curling



Mini Hockey

Bowling

3. A toy that rolls

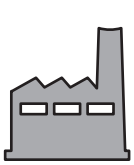
Helpful Knowledge: friction

Friction is a phenomenon that takes place when an object touches another surface while it is moving. An object would move forever without friction.
Sports like curling, bowling, and hockey are cases where friction is minimized to increase an object's speed.

Tips → The surface of a CD is smooth. How can we roll a CD to make it move faster? Think of various shapes that CDs may become when they're combined, so that you can come up with fun ideas while completing the mission.

HOW IMPORTANT IS IT TO RECYCLE RESOURCES?

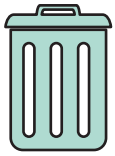
1. The Lifecycle of an Object and Recycling: What is resource recycling?



production

use

Green idea!
Waste? Really? YES



disposal

NO

recycling

Green idea!

Consider the possibilities:
Is it really NOT useful?
Isn't it possible to use it in another way? Can't we reprocess it? Can it be useful for somebody else even though it's not useful for us?

resource recycling

Resource [Noun]: Useful material for human life and economic production
Recycling [Noun]: Reusing used material by re-shaping or reprocessing it to give it a new use

2. A Throw away Culture: How much do we throw away?

500 million tons

People around the world throw away 500 million tons of waste away a day.

26,882

That's equal to the weight of 26,882 Boeing 747 planes.

50%

People around the world use 355 million tons of the paper a year but only about 50% of paper is collected for recycling.

1500L

We can save 1500 liters of oil

4200KW

4200 kilowatt of electricity

28 tons

28 tons of water by recycling 1 ton of paper.

260 million tons

People around the world use 260 million tons of plastic a year.

0.85 tons

We can get approximately 0.85 tons of recycled plastic from 1 ton of thrown-away plastic,

3 tons

and save 3 tons of oil.

3. Born-Again Waste.

The world's attitude toward waste has been changing.
Waste that used to be thrown away has now become a valuable resource for the economy.

India

There has been lots of construction on private recycling factories in one of the biggest slum areas, Dharavi.

Dominican Republic

Recycling companies have been making profits of over 2 billion dollars every year by exporting recyclable waste.

China

The recycling industry has grown rapidly. There are over 10,000 recycling factories now in China.

Japan

An effective recycling system has been established, and it increased the rate of can recycling by about 83%.

Brazil

Uniforms of the Brazil national soccer team are made of eco-friendly material —recycled plastic bottles.

EU

Waste is treated and traded as a valuable resource, since it is now possible to produce electricity by recycling trash. The Netherlands imports over 1 million tons of waste every year from the U.K. and Italy.

What are the advantages of recycling resources?

- We can save energy and water used for production.
- We can save our valuable resources.
- We have less waste to bury.
- We can reduce global warming by producing less carbon dioxide.
- We reduce pollution when we recycle waste for producing electricity.

A

Page	Image contents	Copyright holder
7	Part 1 illustration	Design intro
8	Penicillium mould	Science Museum London, Science and Society Picture Library
8	Penicillin bottles	Design intro
8	The letters and waterdorp	Design intro
8	Magnifier (Lens)	Design intro
9	Hans Lippershey	Pierre Borel
9	Louis Daguerre	Jean-Baptiste Sabatier-Blot, collection of George Eastman House, International Museum of Photography and Film
9	Antonio Meucci	unknown
9	Alfred Nobel	unknown
9	Percy Spencer	Smithsonian Museum
9	Thomas Edison	unknown, collection of the Perry-Castañeda Library
10	Compass	Design intro
10	Gunpowder	Design intro
10	Printing press	Design intro
10	Movable metal type	Design intro
10	Bagel	Design intro
10	Mechanical calculator	Design intro
10	Light bulb	Design intro
10	Transistor	Design intro
10	Artificial satellite	Design intro
10	Dolly the cloned sheep	Design intro
11	Words and Letters delivered by man	Design intro
11	Smoke Signals	Design intro
11	Homing Pigeon	Design intro
11	Morse Code	Design intro
11	Telephone invented by Alexander Bell	Design intro
11	Telephones	Design intro
11	Portable phones	Design intro
11	Smartphones	Design intro
12	Dugout hut	Design intro
12	Modern building	Racingfreak
12	Carriage	Andrew Dunn
12	Car	K3 / KIA Motors
12	ENIAC	U.S. Army
12	Modern PC	ThinkCentre M92/M92p / Lenovo

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20	Bicycle Illustration	Design intro
24	Laser printer	Lexmark CS510de / Lexmark Korea
24	Multi-functional printer	Lexmark X950de / Lexmark Korea
24	Sticker printer	PT-9700PC / Brother
24	Portable printer for smart phone	Instax Share / Fujifilm
24	Wireless printer	CLP-315WK / Samsung Electronics
24	3D printer	C170 / Scoovo
24	Printer with lower drawer	Design intro
25	Bicycle	Classe / ALTON
27	Scissors with multiple blades	Design intro
27	Laser scissors	Laser Guided Scissors / Think Geek
27	Standing kitchen scissors	Design intro
27	Pizza scissors spatula	Design intro
28-29	Soma Cube	Design intro
31	Part 3 Illustration	Beretta
32	Spoon	Design intro
32	Fork	Design intro
32	Spork	Design intro
33	Camera	Design intro
33	Film	Design intro
33	Digital camera	NX mini / Samsung Electronics
34	Bicycle	Classe / ALTON
34	Folding bicycle	Navigator / Montague
34	Bus	New Granbird / KIA Motors
34	Car	PRIDE / KIA Motors
35	Non-slippery gloves	Design intro
35	Non-slippery bowl	WCK9160 / Sillymann Cera
35	Tent	KK8TE0109 / Kovea
35	Mosquito tent	SBT-523 / JS Korea
36	Toilet paper	Design intro
36	Embossed toilet paper with vine pattern	Design intro
36	Tissue box	Design intro
37	Wagon bonnet	Design intro

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37	Kettle	Design intro
37	Watering can	Design intro
38	Vacuum	VK8250LHAY / LG Electronics
38	Toe socks	Design intro
39	Glass bottles	Design intro
39	PET bottles	Design intro
40	Asphalt	Michael Wirtz
40	sidewalk made from waste tires	Design intro
41	Scuba Fins	SF-6 Imprex Tri-Ex / Tusa
41	Helicopter	Matthias Zepper
41	Octopus sucker	Design intro
41	Bee sting	Design intro
41	Dandelion spores	Design intro
41	Parachute	Design intro
41	Injection needle	Design intro
41	Suction plate	Design intro
42	Classic sneakers	[J142375] CT AS Specialty OX / Converse
42	Slip-on sneakers	KV574LGY / New Balance
44-45	22nd Century Invention News	Design intro
47	Part 4 Illustration	Design intro
48	Roly-poly toy	Roly Poly Chiming Clown / TOLO
48	Roly-poly toothbrush	Design intro
48	Principle of roly-poly toys	Design intro
49	Experiment with a fork flying in the air	Design intro
49	Finding supporting point activity	Design intro
49	Activity with a pencil and paper	Design intro
50	Making a bird by using the center of gravity	Design intro
51	Segway	Mauritsvink
51	Balancing Bird	Design intro
51	Seesaw	Corpse Reviver
51	Standing spatula	Swing Shamoji / AKOBONO
51	Standing iron	GC2810 / PHILIPS
51	A pair of scales	BE 25190 / Best Gyogu
52	Balancing game	Design intro
52	Boy character	Design intro
54	Balance Story	Design intro
56-57	Square, Square Logic	Design intro

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60	Rocket	NASA
60	Principle of rocket	Design intro
60	Water rocket	Design intro
60	Air rocket	Design intro
60	Blown balloon illustration	Design intro
61	The law of action and reaction	Design intro
61	Propeller car	Design intro
62	Making a Helicopter	Design intro
63	Water jet pack and fly board	Rusty Clark
63	Hovercraft	Thomas Philipp
63	Recoilless rifle	Sgt. Michael J. MacLeod (U.S. Army)
63	Balloon-powered toy car	Balloon Car / Science time
63	Tire	LTX® A/T2 / Michelin
63	Oar	Sgt. Michael J. MacLeod (U.S. Army)
63	Firecracker	Design intro
65	diagram of an oar	Design intro
66	Action and Reaction Story	Design intro
68-69	Adjusting the Direction of a Paper Plane	Design intro
71	part 6 illustration	Design intro
72	A man and whistle	Design intro
72	Principle of sound in the whistle	Design intro
72	Electric whistle	XH244 / Star
72	Whistle pipe	Design intro
73	Experiment 2	Design intro
74	Making a balloon pipe	Design intro
75	Cheerleading stick balloon	Design intro
75	Phonograph record	Possibly by contributor 'Graham'
75	Stethoscope	Huji, Sonarpulse
75	Maracas	TMS-W / Tycoon Percussion
75	Alarm clock	Sun Ladder
75	Telephone	F l a n k e r
75	Doorbell	DR-201D / COMMAX
76	Van	Grand Starex / Hyundai Motors
76	Ambulance	Jclendenen
76	Kettle	Basic S/S Kettle / Kitchen Flower
76	Whistling kettle	Orange Kettle / Kitchen Flower
76	Stainless steel cup	Design intro

Page	Image contents	Copyright holder
76	Chair	Moi)Chair WH / Casamia
77	Recorder	AWR-SNN(G/B) / Angel Instrument
77	Bongo	Ritmo Natural Bongos / Tycoon Percussion
78	Boy character	Design intro
80-90	What is Sound?	Design intro
83	part 7 illustration	Design intro
84	Roller coaster	Design intro
84	Strong current ride	Design intro
84	Pirate ship ride	Design intro
84	When the bus starts moving	Design intro
84	When the bus stops moving	Design intro
85	Experiment with a wagon and a wooden block	Design intro
85	The Law of Inertia	Design intro
85	Experiment 1	Design intro
85	Experiment 2	Design intro
86	Making a rolling frame	Design intro
87	Top	Design intro
87	Break for automobiles	Julo
87	Dehydrator	SDM-606 / Shinil Industrial
87	Bus handle	Cassiopeia_sweet
87	Bicycle	Turistar / ALTON
87	Airbag	Pineapple fez
87	Vegetable dehydrator	NOBILEX Salad Spinner / Windax
87	Seatbelt	Gerdbrendel
88	Making a paper top	Design intro
89	Various types of tops	Design intro
90	Inertia Story	Design intro
92-93	Make a Paper Boomerang!	Design intro
95	Topic 1 image	Design intro
96	A paper cup and scissors	Design intro
97	A cup with a handle	Design intro
97	Spoon and fork	Design intro
97	Balancing rock	Dschwen
98	Portable cup for camping	ECO Clean Sikgi / UNIFLAME
98	Children's cup	Aejeongmanjeom Milk Cup / Combi
98	Pewter cup	Mug(Sibjangsaeng) / Jinsung
98	Cup for soup	Antic Daisy Soup Mug / FORHOME
99	Adhesive tape and scissors	Design intro

Page	Image contents	Copyright holder
101	Tower of Pisa	Design intro
101	Center of Gravity and Balance	Design intro
102	Making a toddle dog	Design intro
104	Q-Drum	Q drum (www.qdrum.co.za)
105	Money Maker Pump	KickStart (www.kickstart.org)
105	100 dollar laptop XO	One Laptop per Child (laptop.org/laptop/)
105	G-saver	Good Neighbors (www.goodneighbors.kr)
107	Topic 2 illustration	Design intro
108	Glue stick and scissors	Design intro
109	Glue stick	Design intro
109	A cup without a handle	Design intro
109	A cup with a handle	Design intro
110	Fabric pencil case	Design intro
110	Lipstick	Design intro
111	Material for making a model	Design intro
113	Foucault's pendulum	Rémih
114-115	Rolling Down the Three Year Hill	Design intro
117	Topic 3 Illustration	Design intro
118	CD top	Design intro
118	Preparation materials	Design intro
119	CD top	Design intro
119	CD car	Design intro
120	Making a CD top and CD car	Design intro
121	CD barbell	Design intro
121	CD cell phone stand	Design intro
121	CD clock	Design intro
125	Top	Design intro
125	Yo-yo	Design intro
125	Roulette	Design intro
125	Boomerang	Design intro
125	Glider	Design intro
125	Popping balloons	Design intro
125	Curling	Design intro
125	Bowling	Design intro
125	Mini Hockey	Design intro
126-127	How Valuable is Recycling Resources?	Design intro

Who and Why?

The Korean Intellectual Property Office (KIPO), using the Korea Funds-in-Trust supported by the World Intellectual Property Organization (WIPO), has developed course materials to enhance methods of inventive thinking and to promote a basic understanding of intellectual property among today's global youth, including those in developing countries.

The Methods

These course materials were developed through establishing and supporting the operation of invention classes at regular schools, and with the help of the Korea Invention Promotion Association (KIPA) and their experience in developing and promoting many invention education programs.

How Are They Used?

- Experimental research activities connected to the regular curriculum (including science)
- Extracurricular after-school activities for promoting student creativity

To Request These Materials

Contact Information

International Education Division, International Intellectual Property Training Institute, Korean Intellectual Property Office
Tel 82.42.601.4365

Educational Research Institute for the Gifted in Invention, Korea Invention Promotion Association
Tel 82.2.3459.2756

Korean Intellectual Property Office
Government Complex Daejeon Building 4, 189, Cheongsa-ro, Seo-gu, Daejeon, 302-701, Republic of Korea

Tel. +82 42 481 8604
www.kipo.go.kr/en

Korea Invention Promotion Association
Korea Intellectual Property Service Center 131 Yeoksam-dong, Gangnam-gu, Seoul, 135-980, Republic of Korea

Tel. +82 2 3459 2768
www.kipa.org/english