SCIENCE AND MATH WORKSHOP 2018

South Korea–Tanzania Collaboration Workshop

On 30 - 31 JULY 2018 At DIT Mwanza in Tanzania

Hosted by : HSOT(Hands on Science Organization Tanzania), Korea Science Teachers Association Meeting

Contents

Preface 1

I want to tell you about my old experience. In 1998, Korea was in a state of IMF management. The exchange rate has risen from 800 won to 1,400 won and the bank interest is also 14~20%, people with debt were hard to stand, and many companies were ruined. The companies had been reduced in size, and the number of the unemployed had surged. Many Koreans immigrated because Korea was hard to live. One of my friends also immigrated to Canada. I was also swayed. How about I leave Korea which have a lot of trouble?

At that time, there was a teacher who suffered from various hardships as well as being dismissed because of a democratization movement. I asked him.
"Do not you want to leave this country?"
I thought the teacher deserved to blame the Republic of Korea. I still remember what he said to me at that time. "What are you talking about ~ There're so many things I can do in Korea ~" While I didn't do anything but complain, the teacher who was bumping into hardship was concentrating on solving problems. Over the next 20 years, I've grown a lot and now I do a lot of work. Inside school, I operate student clubs, teacher clubs and so on. Outside the school, I participated in local children's center classes, teachers meetings, teachers' trade union activities, and something like this Tanzania seminar!
I did not do such many work from the beginning. When I am working, I can see what I need to do. If it is good, there will be someone to join. Take a look at the Tanzania Workshop. So many people are together even they need to spend about a year to prepare and pay for themselves.
I want to ask you something.
1. Resolve the problem in front of you. Start now.
2. And come together. Describe your work and ask for help.

There were many struggles until today's seminar. TAMISEN's permission was delayed so we have many difficulties in working. Maybe someone think "This is Africa." in difficulty. I was sad of seeing the process progress, but I thought this may become a grace. I thought it became a process of confirming our thoughts by thinking 'What do I really want to do?' 'Is this really necessary?'

Everyone! Do you need a Korea - Tanzania workshop?
Will you join in this?

We are conducting a workshop for three years. This year is the second year. This year, unlike last year, we have held workshops on each subjects, and Tanzanian teachers have presentation in each subject. The meaning of our workshop is simple. Education can change the future. The center of the education is the student. Let's make the student-centered education. We talk face to face and discuss the way.

I hope this workshop will be an effective workshop to discuss that plan.

_____
LEE SUNHEE
Representative of participating teachers in Korea,
Members of Science Sharing for SARANG
JUNE,2018.

Preface 2

The Government of Tanzania has decided to intensify its effort to expand science education by building laboratories in all secondary schools in order to meet the high public demand for this level of education; this resulted from the increase of enrolment at primary school. Also in 2004, Secondary Education Development Plan (SEDP) was launched which increased number of students in secondary schools and new community schools was established.

Despite of these effort, teaching and learning Science in Tanzania has continued to face a number of Challenges which contribute to inadequate of good performance in science subjects. Some of these challenges are lack of teaching materials in science, good teaching methodologies in crowded classes, inadequate skills of science teachers. These inadequacies have a direct impact on performance of teachers in facilitating the learning process. Lack of practical knowledge and skills in science subjects reduces achievement in learner's expected competencies.

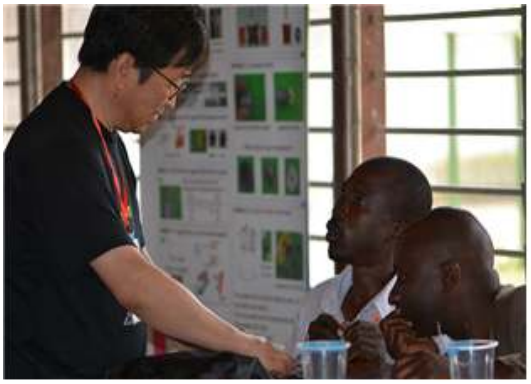
HANDS ON SCIENCE ORGANIZATION T ANZANIA (HSOT) has prepared to respond to the deficiencies noted in the teaching and learning science subjects. Members have many case study related to good teaching methodologies in science.

HANDS ON SCIENCE ORGANIZATION TANZANIA (HSOT) meant to equip the teachers with adequate skills and knowledge, hence promoting the teaching and learning of science in the country. It is my hope that, science teachers in Tanzania will have a great benefit in their professional through HANDS ON SCIENCE ORGANIZATION TANZANIA (HSOT).Other science education stakeholders are school inspectors, examiners, curriculum developers and college tutors.

_____

DAN KITAMBALA IBRAHIM
CHAIRMAN
HANDS ON SCIENCE ORGANIZATION TANZANIA
JULY,2018.

Photos of past 2017 workshop activities



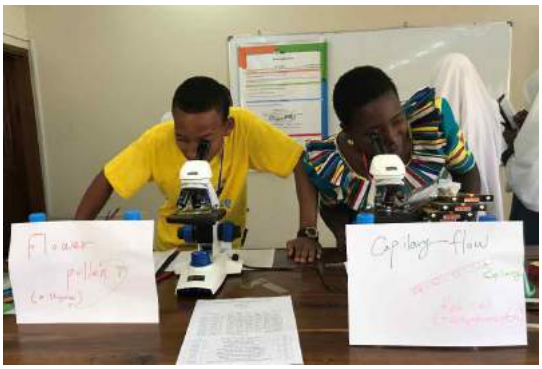





Photos of past 2017 workshop activities








Workshop schedule

1. Workshop Time table

		30. July(Mon)								31. July(Tue)							
Room		R1	R2	R3	R4	R5	R6	R7	R8	R1	R2	R3	R4	R5	R6	R7	R8
07:30 ~ 8:00 Arriving time 08:00 ~ 8:30 chai time																	
08:30~ 10:10	NO. of Topics	Open ceremony								1	3	5	7	9	14	11	13
	Group									B	A	D	C	F	E	H	G
Break																	
10:30~12:10	NO. of Topics	1	3	5	7	9	12	11	13	2	4	6	8	13	10	12	14
	Group	A	B	C	D	E	F	G	H	B	A	D	C	F	E	H	G
12:10~13:10		Lunch								Lunch							
13:10~14:30		**Presentation by HSOT** 4 Case Study								**Open Booth by HSOT** 8 rooms, All topics							
14:30~16:10	NO. of Topics	2	4	6	8	11	10	12	14	Special Lecture Java Lab(Dongjun Lee)							
	Group	A	B	C	D	E	F	G	H								
16:10~17:50		world cafe								Farewell Party							

2. Experiment Topics

(Teacher Workshop, Student Experiment Booth)

NO of Topics	TOT of KR	TOT of TZ	Experiment Topics(for Teacher)	Experiment Topics(for student)
1	SONG YOUNG IL	Abel Nestory	Properties of the square root and Tangram	Tangram
2	PARK DAE WON	Elberte Kente	Deriving binomial theorem using letter cards and interesting combination problem	Solve the twisted arms!
3	NA EUN YOUNG	Andrew Lyagunga	Vector	Making Quve
4	LEE CHUNGROK	Hamza Buchu	Creating Cubes with Nine Colours	Nine Colours!
5	LEE SUN HEE	Sungura	Straightness and reflection of light	Kaleidoscope:How many images are there?
6	CHUN SANG HEE	Mtafya Jickson	Let`s make chameleon Table tennis ball	mixing light
7	KIM HYUN KYUNG	Mayombya Lata	Refraction and Polarization of light	A polaring bookmark
8	LEE DONG JOON	Majani Joseph	How transistors work	Making electricity
9	SEO IN HO	Sala Samwel	Electrolysis, Fun and Easy	The traffic signal reaction of Glucose and Oxygen
10	KIM MIN SEON	Heartman Mnema/ Yusinta Shija	Studying Acid Rain	Metal Reactivity and Making Electricity from Fruits
11	KIM KYEONG SOON	Restuta	How does natural selection occur?	How does natural selection occur?
12	KIM MI JUNG	Hapyness Justian	Learning cell division using model	Making straw fingers
13	CHOI YOON HEE	Smawel Muharagi/Daudi	DNA extraction and making a DNA model	Making breathing model
14	KIM KYOUNG TAE	Kakulilo Ferdinand	Causes that affect the size of the population	Causes that affect the size of the population

Experiment Topics

Properties of the square root and Tangram

Song Young Il / Abel Nestory syil95@hanmail.net

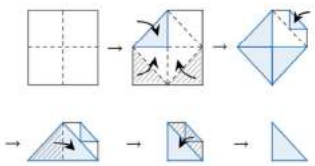
Tangram

Tangram is an old puzzle game with square divided by 7 pieces.

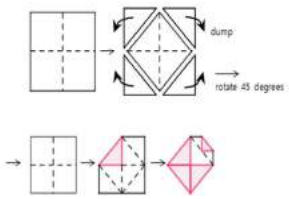
2 of large triangles, 2 of small triangles, 1 medium-size tria ngle, 1 square, 1 pa rallelogram.

Activity 1 : Make 7 Shapes

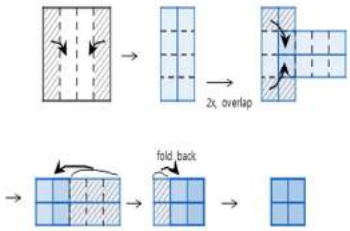
1. Triangle (2 Large Size)



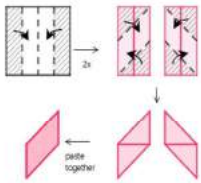
2. Triangle (1 Middle Size)



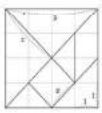
3. Square

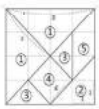


4. Parallelogram



Activity 2 : Compute Length and Area of Shape of Tangram (Sheet 1)





1. Complete x, y, z

2.

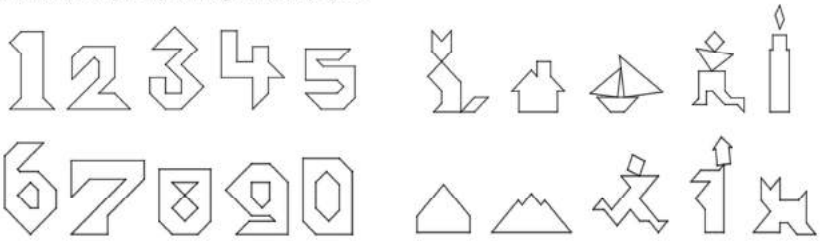
Shape	Side length			Area
①				
②				
③				
④				
⑤				

3.

	Figure	Area of square	Side length
Square with 1 piece			
Square with 2 pieces			
Square with 3 pieces			
Square with 4 pieces			
Square with 5 pieces			
Square with 7 pieces		16	4

Activity 3: Make various Shape (Sheet 2)

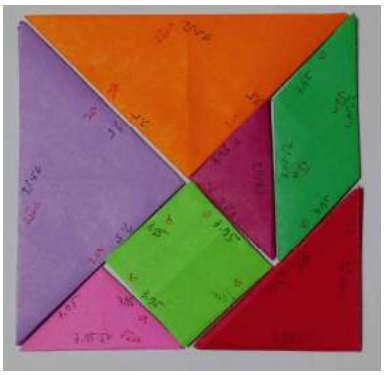
Make various shapes by cutting colored papers



01. Properties of the square root and Tangram

Song Young Il

Ⅰ. Introduction

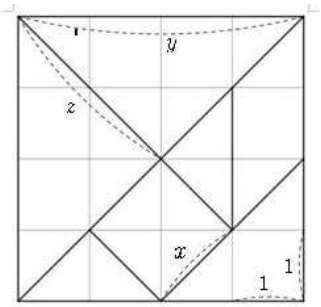


Tangram is an old puzzle game with square divided by 7 pieces. It is called 'Tangram' in english because it was introduced to West during Tang dynasty(Ancient China).

Tangram can be used for many activities using pieces of triangles and squares, which are basic shapes of the plane geometry. It is effective in developing mathematical thinking, creativity and spatial perception.

Tangram consisted of 7 geometrical shapes. Which are 2 of large right-angle isosceles triangles, 2 of small right-angle isosceles triangles, 1 medium-size right-angle isosceles triangle, 1 small square, 1 parallelogram. 7 shapes have certain ratio of its length of side and area, so we use square roots to compute its length of side and area. We compute the area of the figure by comparing with the unit area and understanding the area of the figure through the activity comparing the size. And through this activity, we can naturally understand the geometrical concept like the area, congruence, similarity, symmetry.

Ⅱ. Learning Goals



· We can compute length of side and area of each shape using Tangram.
· We can make a square with various pieces. Compute length of side and area of the square and understand the properties of square roots.
· We can make Tangram by folding colored papers.
· We can make various shapes by Tangram.

Ⅲ. Equipments

· colored paper, scissors, glue, activity sheet

Ⅳ. Class Outline

Order	Activity theme	Time(minute)
1	Computing length and area of shape of Tangram Making Tangram by folding colored papers	60 mins
2	Making various shapes by cutting colored papers Creating your own shapes	40 mins

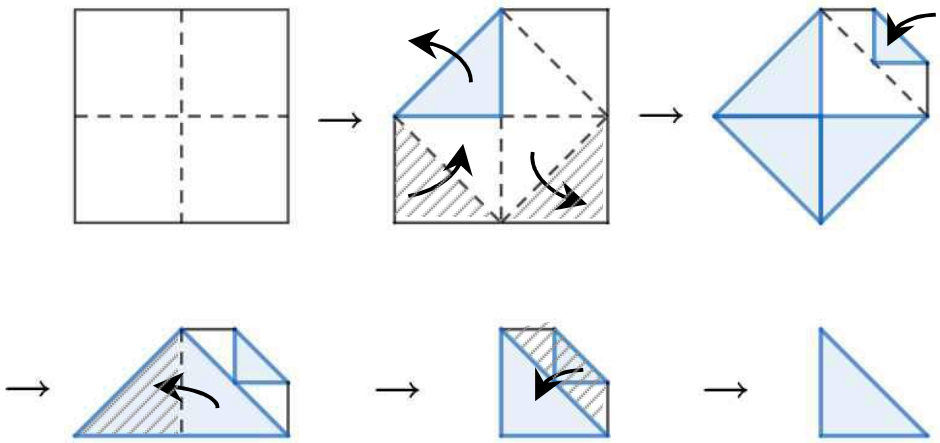
V. Activity Process

Activity 1 : Compute length and area of shape of Tangram (sheet 1)

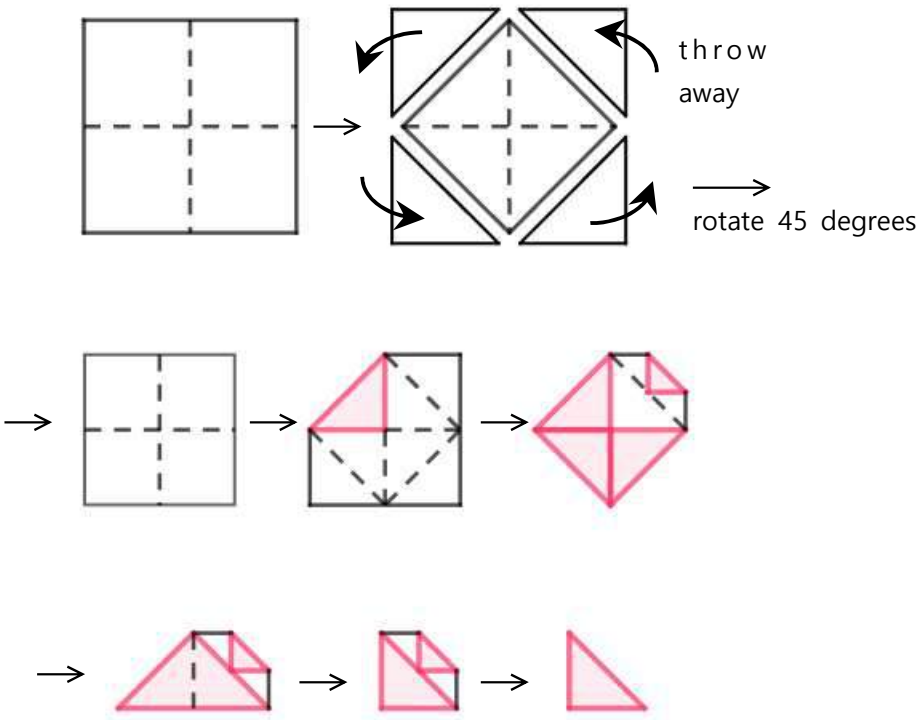
1) Compute x, y, z and area of each shape.

2) Make 7 shapes by 5 colored papers.

① large right-angle isosceles triangle(2x)



② the medium-size right-angle isosceles triangle(1x)

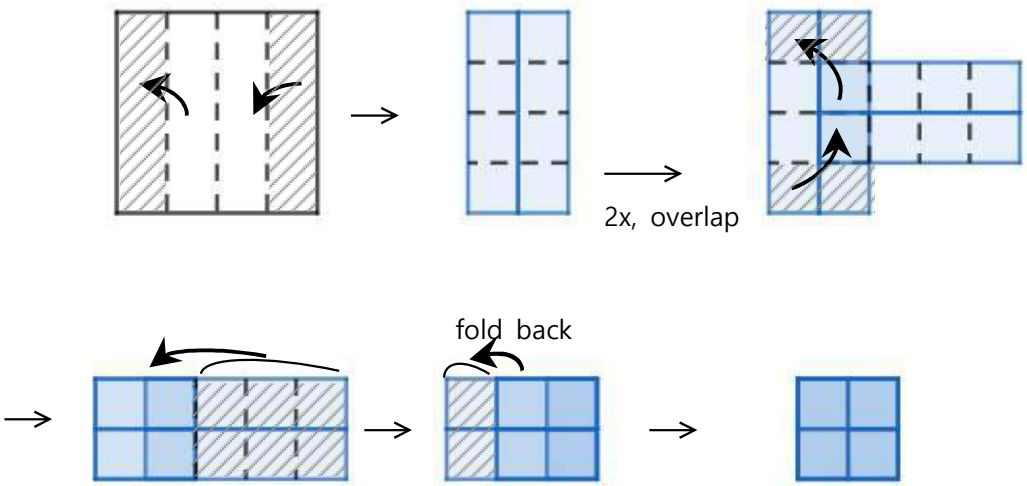


③ small right-angle isosceles triangle(2x)

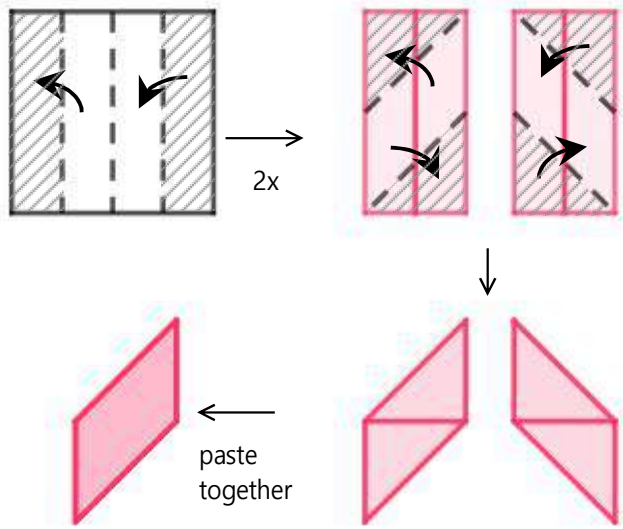
divide 1 square paper into 4 smaller squares. repeat like ①.

④ small square(1x)

divide 1 square paper into 4 smaller squares. we will use 2 out of the 4 small squares.



⑤ parallelogram(1x)



3) Make a square using the pieces of paper. You can use the different number of paper each time.
   ① Make a square using one piece of paper.
   ② Make a square using two pieces of paper.
   ③ Make a square using three pieces of paper.
   ④ Make a square using four pieces of paper.
   ⑤ Make a square using five pieces of paper.

4) Compute side length and area of square as the hypotenuse length of a large right-angle isosceles triangle is 4.

Activity 2 : Make various shapes by cutting colored papers (sheet 2)

1) Cut 1 colored paper into 4 same squares.
2) Cut each piece of paper into 7.
3) Fill the figures and numbers in <Activity sheet 2> with the 7 pieces of paper fit into the shape which is figure and number.
4) create your own shapes

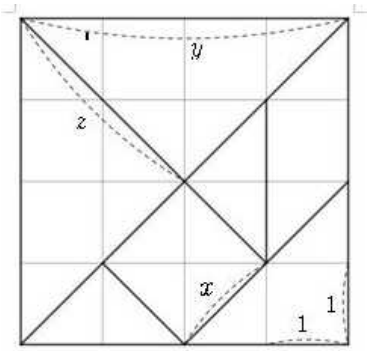
Ⅵ. Conclusion

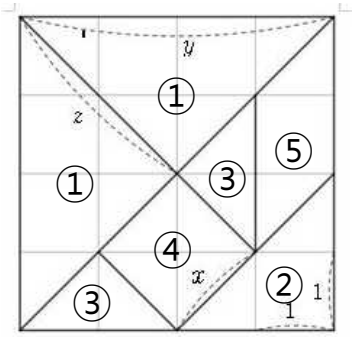
(1) We can obtain length and area of shape of Tangram.
(2) We can create squares with various pieces and understand the properties of square roots.
(3) We can improve our ability to think through activities matching shapes and understanded the principle of symmetry through making symmetrical shape and finding the center of symmetry.
(4) Make shapes according the conditions, and develop to solve problem by talking about features of shapes.

Ⅶ. References

「쉽고 재미있는 중학교 수학 탐구」, 서울특별시교육청(2005), p84-86
스쿨에듀, "칠교놀이", http://flowmath.schooledu.co.kr, (2018.02.19.)

<sheet 1>





1. (1) compute x, y, z.

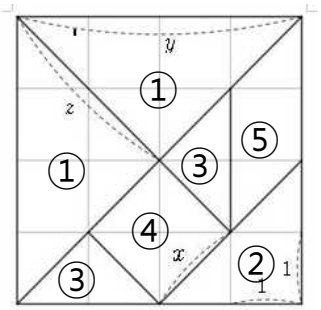
(2) Fill in the blanks with appropriate numbers.

Shape	Side length				Area
①					
②					
③					
④					
⑤					

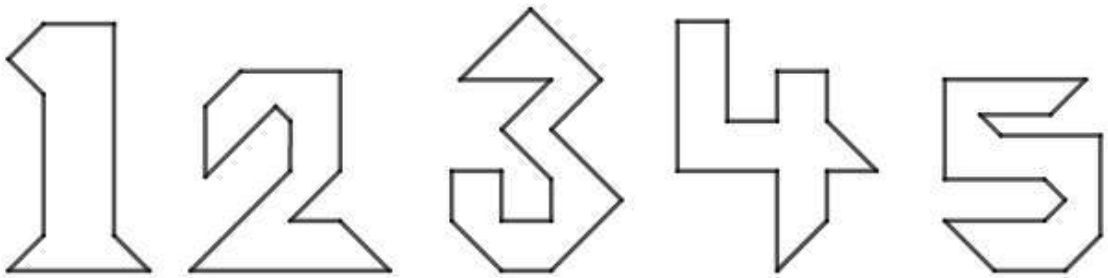
2. Make Tangram by folding colored papers.

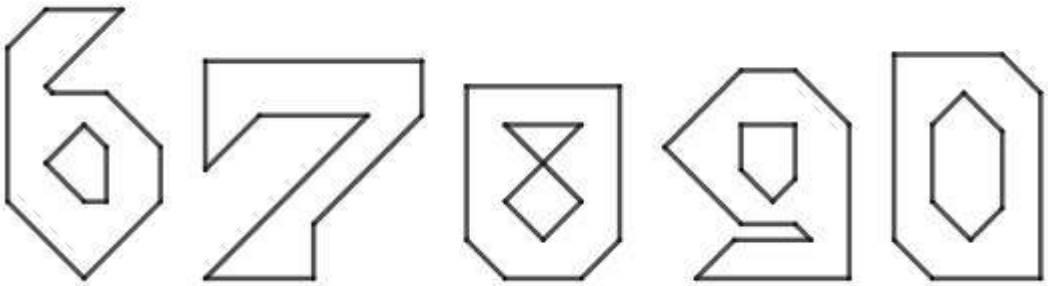
3. Make squares of various sizes.

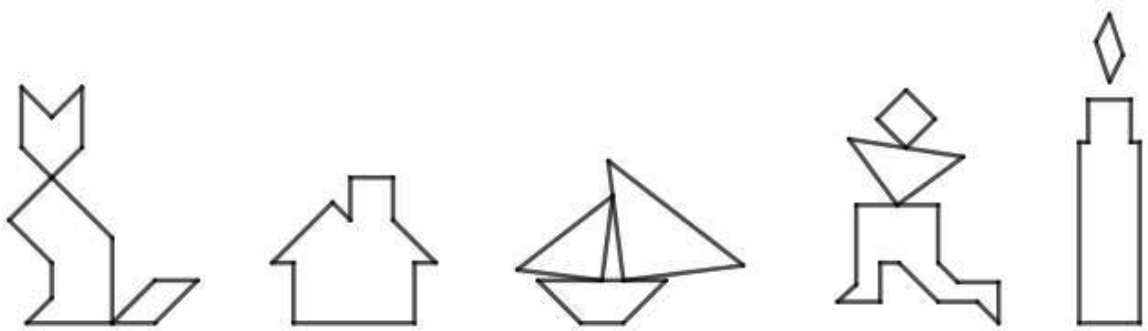
Suppose that the side length of the biggest square is 4. Fill in the blanks.

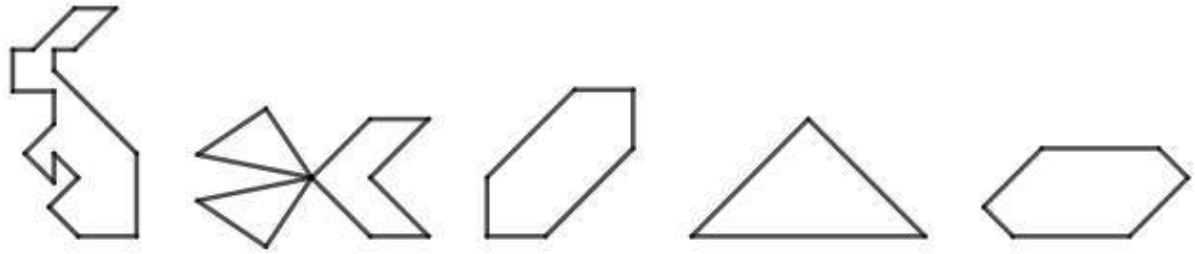
	Figure	Area of square	Side length
Square with 1 piece			
Square with 2 pieces			
Square with 3 pieces			
Square with 4 pieces			
Square with 5 pieces			
Square with 7 pieces		16	4

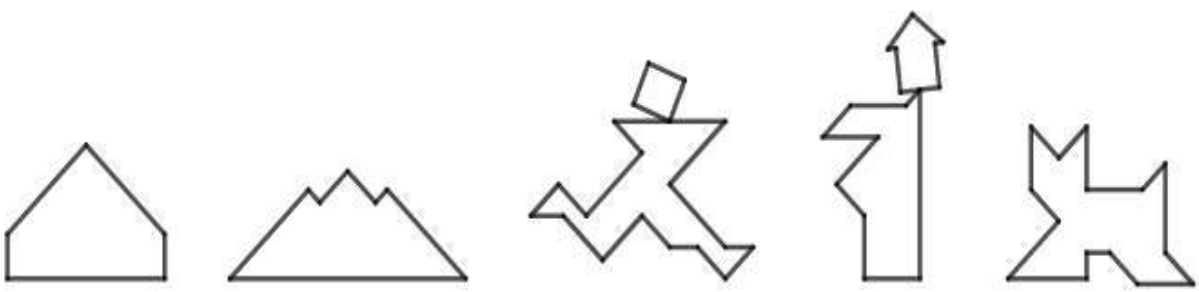
<sheet 2>



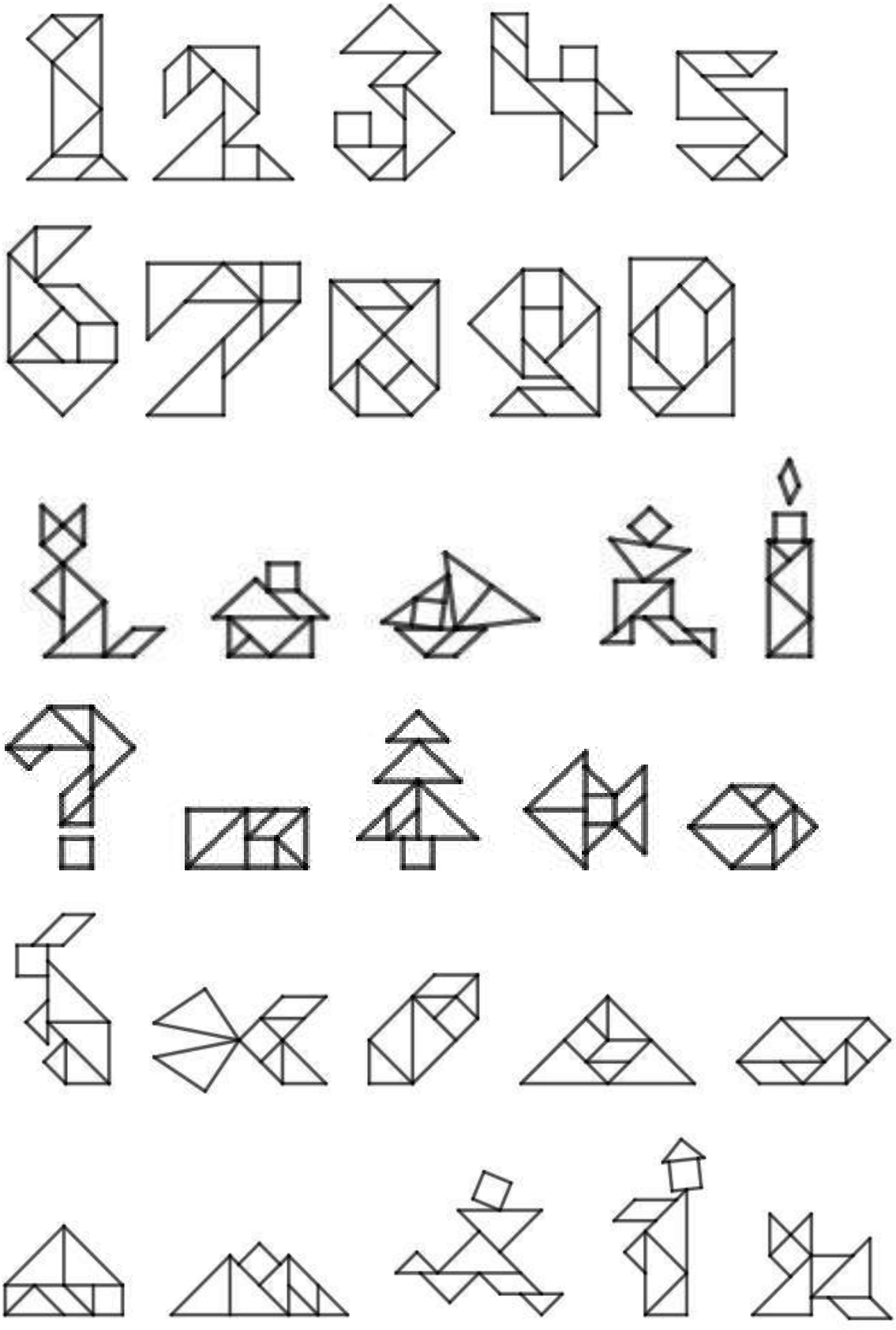








<answer of sheet 2>



Korea-Tanzania Mathematics & Science
2018 teachers PD workshop

Hands on Science Organization Tanzania
(HSOT)

Deriving binomial theorem using letter cards And interesting combination problems

DaeWon Park, Elberte Kente gibenrat@gmail.com

Activity 1. Deriving binomial theorem using a character card

Goal>
You can derive the expansion for $(a+b)^n$ by performing multiplication expansion manually using a and b character cards.

Activity process>

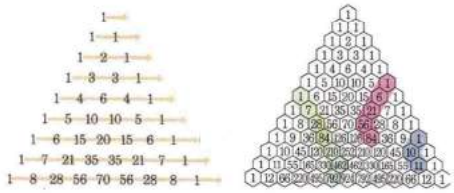
Beginning with two parentheses, to three or four parentheses,

List all the multiplication cases by selecting one character in each parenthesis

Let students find and tell the patterns

Q1) In Multiplication distribution of (a+b)(a+b)(a+b), How many terms will appear?

Activity 2. Understanding the relationship between binomial theorem and Pascal's triangle



Goal>

Look at the relationship between the sequences in the Pascal triangles and the coefficients of the binomial theorem.

Activity process>

In Pascal 's triangle, find the sequences with regularity and draw a horizontal or diagonal line.

Ex) $_nC_0+{}_nC_1+\cdots+{}_nC_n=(1+1)^n$ es considering the relation with the coefficients of the binomial theorem.

$_nC_0-{}_nC_1+{}_nC_2-+\cdots(-1)^n\cdot{}_nC_n=(1+(-1))^n$

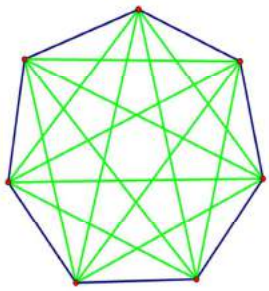
$_nC_0+{}_nC_2+{}_nC_4+\cdots={}_nC_1+{}_nC_3+{}_nC_5+\cdots=2^{n-1}$

Activity 3. Introduce some interesting combination problems

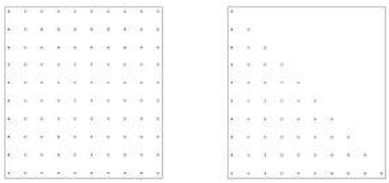
Goal>
Explore various solutions of interesting problems associated with combination.

·problems and Think of various solutions >

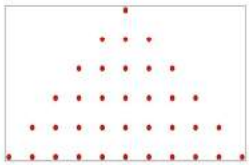
1) Calculate the number of intersections when all corners of a convex n square are connected together. (However, the shape of the intersection is a cross shape)



2) If We make a rectangle on the 10x10 grid below, how many can We draw all?
(However, the rectangle is drawn in the horizontal and vertical directions)



3) If We make a rectangle on the 10x10 grid below, how many can We draw all rectangle?



02. Deriving binomial theorem using letter cards and interesting combination problem

Park Dae Won

Ⅰ. Introduction and Background

Binary theorem is about the rules that appear when the power of the binomial is expanded. However, this rule is a topic that many students find difficult because it is expressed in a very complex way in relation to the combination. Therefore, if we do not understand the reason why binomial theorem is derived correctly, we can not solve various applied problems, and we have to memorize various equations related to the combination derived from binomial theorem unconditionally. In this lesson, we try to understand the process of naturally understanding why the coefficients of the opening ceremony are related to the combination by developing it directly using the letter card, and we will examine some interesting combinations.

Ⅱ. Learning Objectives

· Run the binomial expansion of the binomial using a character card by hand to derive the binomial theorem.
· Increases mathematical thinking through interesting combination problems.

Ⅲ. materials

· 'a' and 'b' Each of the 30 character cards (1 pair), activity sheets.

Ⅳ. Class outline

순서	활동주제	소요 시간(분)
1	Deriving binomial theorem using a character card	30분
2	Understanding the relationship between binomial theorem and Pascal's triangle	30분
3	Solve An interesting combination problem	40분

Ⅴ. process

activity 1 : Deriving binomial theorem using a character card

· goal : You can derive the expansion for $(a+b)^n$ by performing multiplication expansion manually using a and b character cards.
· materials : Give a and b letter cards to each pair of 30 cards. One A4 sheet.
· Activity process

1) Place a (+)(+) on the paper and a and b letter cards before and after the plus sign.

2) Select each character in each parenthesis, display = on the right, and let it line up.

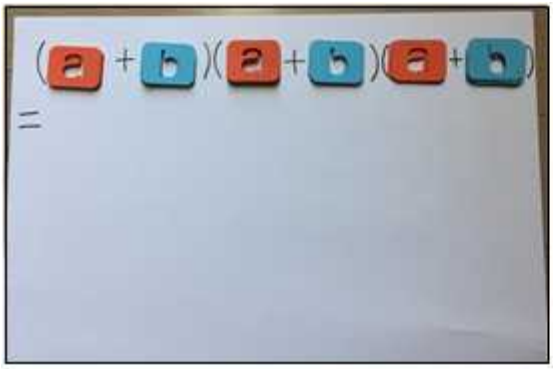
3) Select the character selected in the left parenthesis and the character selected in the right parenthesis, and place it side by side when you place it on the right side.

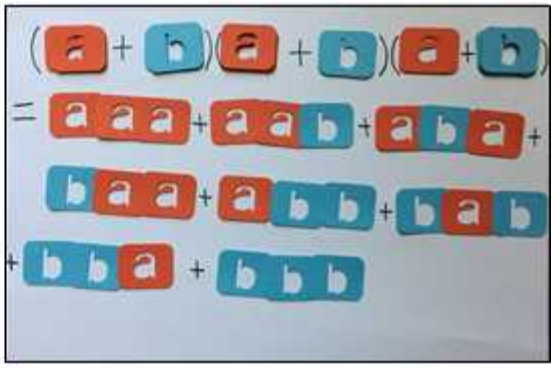
4) Expresses the character cards listed in the form.

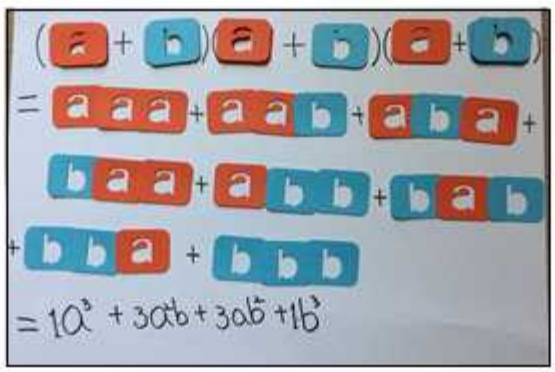
5) express (+)(+)(+) And repeat steps 1) to 4).

6) express (+)(+)(+)(+) And repeat steps 1) to 4).

7) From the results of (4) to (6), Let students find and tell the patterns .







· Results and organization

1) In this exercise, what is the mathematical meaning of selecting one character in each bracket and putting it on the right?

- The multiplication distribution is applied to list one term.

2) In all cases, what characteristics do you see when you list character cards on the right?

- The character cards listed represent each term in the binomial expansion, and the number of character cards used in each term is always the same.

3) (+)(+)(+) In this case, what are the number of terms with two a

character cards and one b character card, and how many of these terms can be found using the combination?

- The order in which the character cards are attached (in mathematical sense, the letters are multiplied) is different, but the number of characters used is the same in all three. This is like ${}_3C_2$. This is because you have chosen the a character card in the parentheses of two of the three parentheses and only the b character in the other parenthesis.

4) (+) Is multiplied by n times, can we express the expansion of the binomial equation as an equation?

- If you answered well to question 3), you would be able to generalize. Also, If (+) is multiplied by 2, 3 and 4, and the relation between the coefficients is found, the general expression can be found for n times multiplication.

activity 2 : Understanding the relationship between binomial theorem and Pascal's triangle

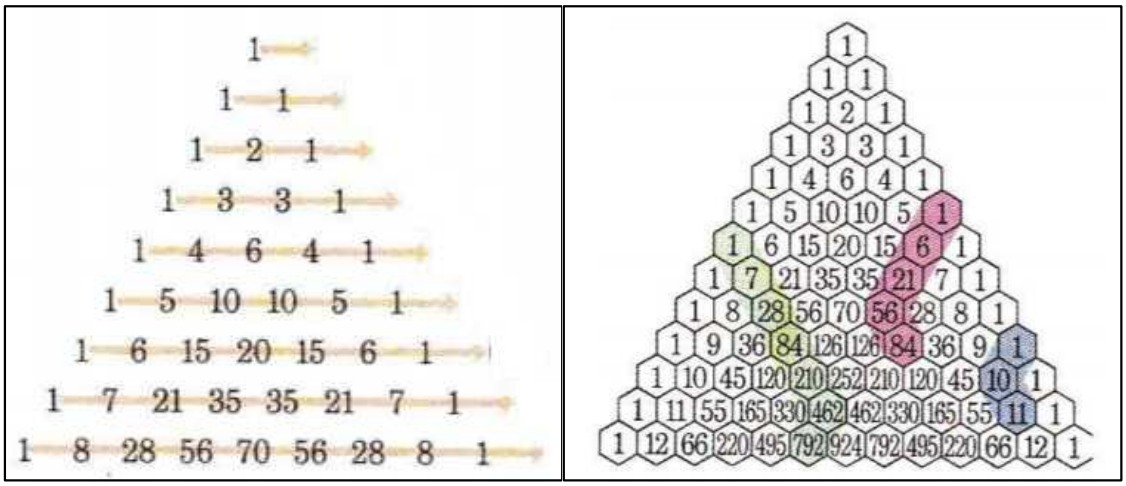
· goal : Look at the relationship between the sequences in the Pascal triangles and the coefficients of the binomial theorem.

· materials : An activity sheet that printed Pascal's triangle.

· Activity process

1) In Pascal 's triangle, find the sequences with regularity and draw a horizontal or diagonal line.

2) Expressing the sequences that draw the lines considering the relation with the coefficients of the binomial theorem.



· Results and organization

1) In the horizontal direction, we can find the regularity of the sum of two sequences.

-(1) 1+3+3+1 = ${}_3C_0+{}_3C_1+{}_3C_2+{}_3C_3=(1+1)^3$

When generalized, ${}_nC_0+{}_nC_1+\cdots+{}_nC_n=(1+1)^n$.

-(2) $1-3+3-1=0={}_3C_0-{}_3C_1+{}_3C_2-{}_3C_3=(1+(-1))^3$

When generalized, ${}_nC_0-{}_nC_1+{}_nC_2-+\cdots(-1)^n\cdot{}_nC_n=(1+(-1))^n$

-(3) From (1), (2) ${}_nC_0+{}_nC_2+{}_nC_4+\cdots={}_nC_1+{}_nC_3+{}_nC_5+\cdots=2^{n-1}$

2) You can find a combination formula for the hockey stick formula.

- ${}_rC_r+{}_{r+1}C_r+{}_{r+2}C_r+\cdots+{}_nC_r={}_{n+1}C_r$
- ${}_rC_0+{}_{r+1}C_1+{}_{r+2}C_2+\cdots+{}_nC_{n-r}={}_{n+1}C_{n-r}$

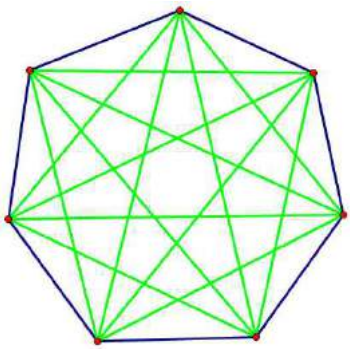
activity 3 : Introduce interesting combination problems

· goal : Explore various solutions of interesting problems associated with combination.

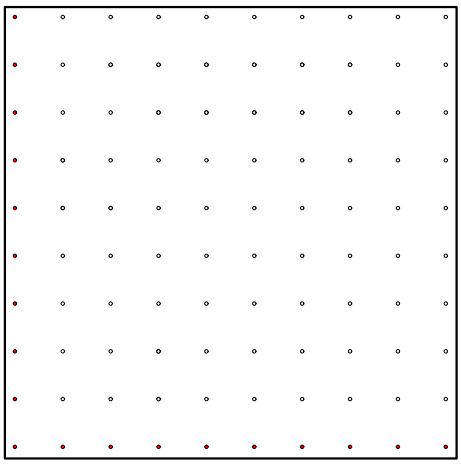
· materials : Activity sheets & Writing Tools

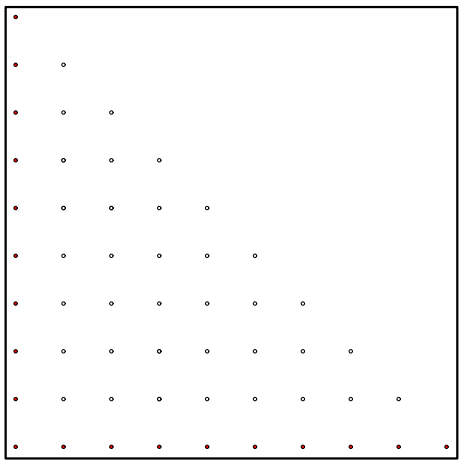
· Activity process

1) Calculate the number of intersections when all corners of a convex n square are connected together. (However, the shape of the intersection is a cross shape)



2) If We make a rectangle on the 10x10 grid below, how many can We draw all? (However, the rectangle is drawn in the horizontal and vertical directions)





· Results and organization

1) Find all the number of intersections when all corners of a convex n square are

connected together.

The cross shape of the intersection is that the number of line segments passing through the intersection is exactly two. And since the convex n-line segment is connected to two corner points, the number of intersection points can be obtained by combination.

2) Draw a rectangle over the grid!

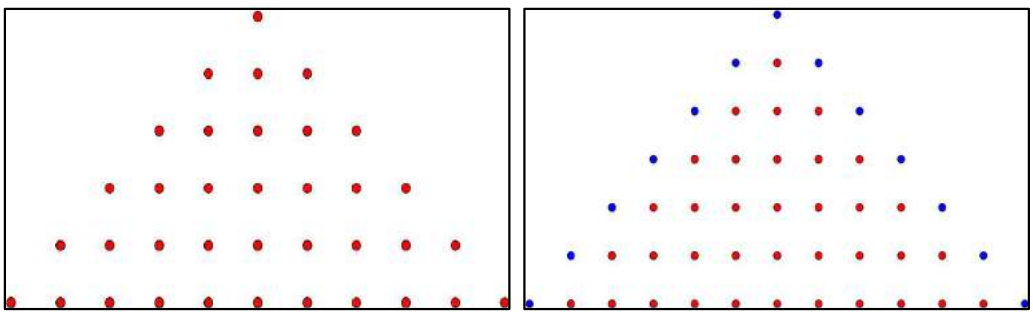
-(1) Obtain the number of all rectangles that can be drawn on a square, rectangular grid. The rectangle is determined by two opposing stools. Therefore, you can get it by using the combination twice.

-(2) Find the number of all rectangles that can be drawn on a right triangular grid. In a rectangle where one side is inclined, a rectangle may not be formed when two points are arbitrarily selected. What should We do? And teachers can ask students to think of various solutions. An answer is ${}_{10}C_4+{}_{10}C_3$! why?

As a solution using other ideas,

There are ${}_8C_1\cdot{}_2C_2+{}_7C_1\cdot{}_3C_2+{}_6C_1\cdot{}_4C_2+\cdots+{}_2C_1\cdot{}_8C_2$ and ${}_{11}C_4$.

-(3) Obtaining the number of all rectangles that can be drawn on a triangular grid with two sides that are inclined.



${}_4C_1\times{}_3C_2+{}_3C_1\times{}_5C_2+{}_2C_1\times{}_7C_2+{}_1C_1\times{}_9C_2$

VI. References

1. George Pólya (1973). How to solve it

2. 네가미 세이야 (2009). 수학 시크릿 (고선윤 역) : 바다출판사. (원저 2007년에 출판)pp.54 - 62

3. 윤마병 외 1명 (2016). A Study on Binomial Coefficient as an Enriched Learning Topic for the Mathematically Gifted Students : Journal of the Korean School Mathematics vol 19 no. 3, pp.291 - 308

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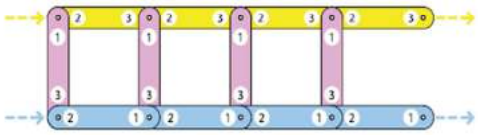
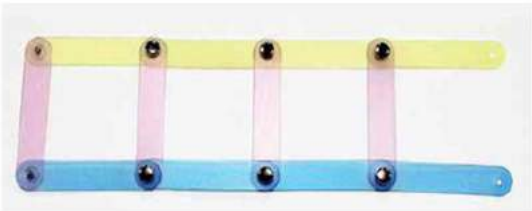
Magic Stick

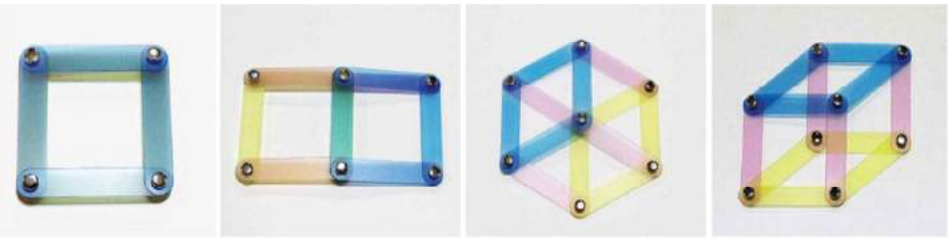
Na Enyoung/Andrew L. ena1561@naver.com

Making a Magic Stick





Transformation of Hexahedron (Cube)



03. vector

Na eun young

Ⅰ. An introduction to vectors

Definition of a vector

A vector is an object that has both a magnitude and a direction. Geometrically, we can picture a vector as a directed line segment, whose length is the magnitude of the vector and with an arrow indicating the direction.

Two vectors are the same if they have the same magnitude and direction.

Ⅱ. Learning Objectives

· Creating shapes to understand the equivalent vectors.
· To know the sum and difference of vector.
· To know multiplication by scalar

Ⅲ. Materials

· Woolen yarn, USB, Magic sticks, Prints

Ⅳ. Program Overview

Procedure	Activity Topics	Time required (minutes)
1	Throwing yarn (To introduce myself)	20분
2	Creating a figure (Magic sticks)	35분
3	Solving Vector Problems	45분

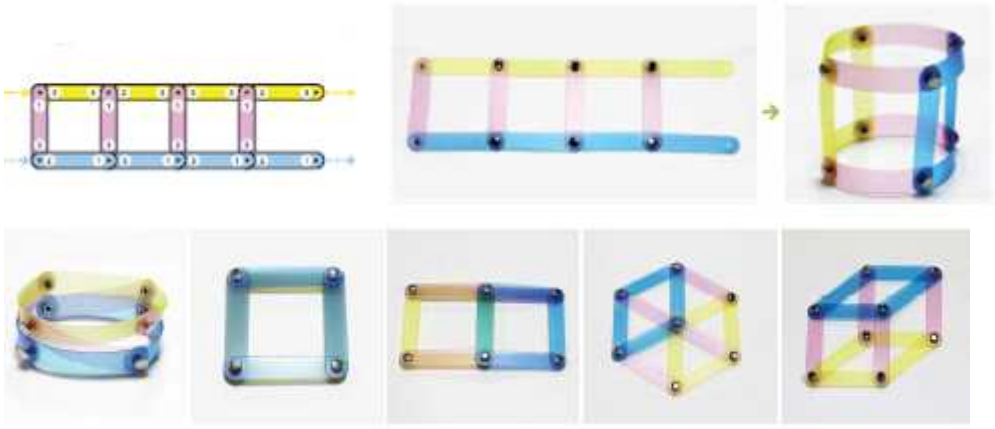
Ⅴ. Procedure

Activity 1 : Throwing yarn

1) The teacher who receives the yarn talks to the name, workplace, bucket lists, etc.
2) When you are finished with your introduction, throw the yarn to the other teacher.
3) After everyone's introduction, all teachers raise the connected yarn.

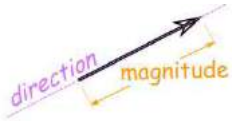
Activity 2 : Magic sticks (Cube, Cylinder)

1) Place the first **sticks** at the bottom, and the second **sticks** above it.
2) Put the second **sticks** down and put the third **sticks a**t the top.
3) Place the bottom and top correctly, step by step.

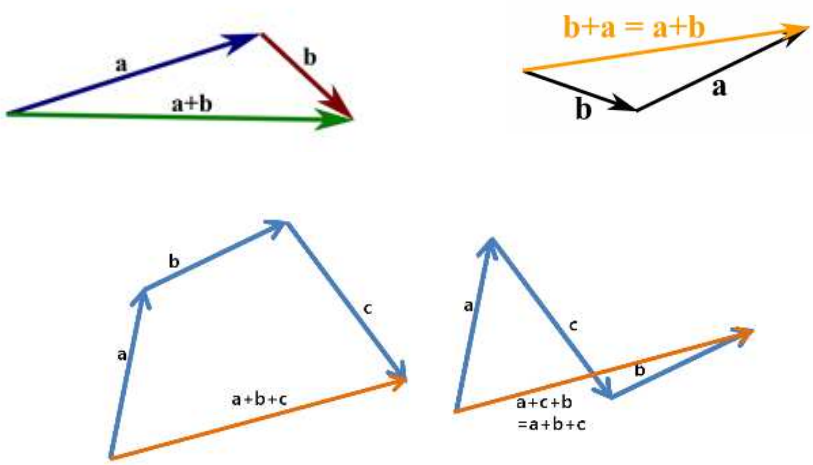


Activity 3 : Vector

1) A vector has **magnitude** (size) and **direction**

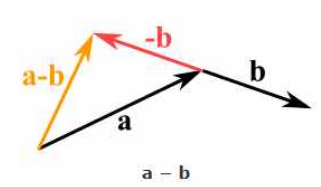


2) The **length** of the line shows its **magnitude** and the **arrowhead** points in the direction. **Add** two vectors



Practice the addition of vectors using **Magic sticks** above.

3) **Subtracting**



4) **Magnitude** of a Vector

The magnitude of a vector is shown by two vertical bars on either side of the vector: $\overrightarrow{A}$

We use Pythagoras' theorem to calculate it:

$$\overrightarrow{A} = \sqrt{x^2 + y^2}$$

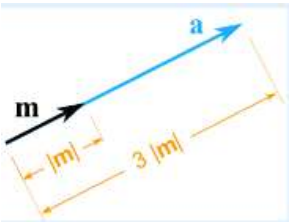
ex.) What is the magnitude of the vector B = (6,8) ?

$$\overrightarrow{B} = \sqrt{6^2 + 8^2}$$

***Watch videos to understand vectors:** https://www.youtube.com/watch?v=bBBCFr-5XkI
https://www.youtube.com/watch?v=aPjitrcRpd8

5) **Multiplying** a Vector by a Scalar

ex.) Multiply the vector $\overrightarrow{m} = (7, 3)$ by the scalar 3



$\overrightarrow{a} = 3\overrightarrow{m} = (3 \times 7,\ 3 \times 3) = (21, 9)$L

It still points in the same direction, but is 3 times longer.

VI. References

1) https://www.mathsisfun.com/algebra/vectors.html

Nine Colours

C.R. Lee / Hamza Buchu chung81790@gmail.com

Purpose of Lesson

1. Solve "Creating Cubes"
2. Solve "Nine Colours"

Preparation

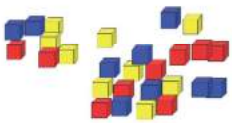
1. A set of 27 color cubes, 9 of each colors (3 colors)
2. A set of 27 color cubes, 3 of each colors (9 colors)

Activity Procedures

Creating Cubes

You need:
27 small cubes, 9 each of any 3 colours.

Arrange them into a large **3 by 3 by 3 cube** so that, on each face of the large cube, **no row** or **column** of cubes contains **two** cubes of the **same** colour.



nrich.maths.org/roadshow

Nine Colours

You have 27 small cubes, 3 each of nine colours.

Can you use all the small cubes to make a 3 by 3 by 3 cube so that each face of the bigger cube contains one of each colour?

nrich.maths.org

Key Questions

[Creating Cubes]

1. How could you start the cube?
2. Is there only one way?
3. Have you all got the same solution?
4. Are there similar solutions?

[Nine Colors]

1. How many cubes have no visible faces?
2. How many cubes have one face visible?
3. How many cubes have two faces visible?
4. How many cubes have three visible faces?
5. If one color appears in a corner, where will the other two cubes of same color need to appear?
6. There will be a cube in the center. Where else will cubes of that color need to be positioned?

04. Creating Cubes with Nine Colours (Two Activities)

Lee Cung Rock

Ⅰ. Introduction and Backgrounds

The Nine-Colour Cube is a cubic twisty puzzle. It was invented in 2005 by Milan Vodicka. Mechanically, the puzzle is identical to the Rubik's Cube; however, unlike the Rubik's Cube, which only has 6 different colours, the Nine-Colour Cube has 9 colours, with the individual pieces having one colour each. The difference between the two puzzles is their purpose: on a standard Rubik's Cube, the aim is to arrange the puzzle in such a way that every face has only one colour; on the Nine-Colour Cube, the goal is opposite: to arrange it so that every face contains all nine colours exactly once.

Ⅱ. Learning Objectives

· By using cubes or the interactivity, we hope students will become absorbed so that they are willing to think logically, work systematically and persevere.

Ⅲ. Classroom Materials

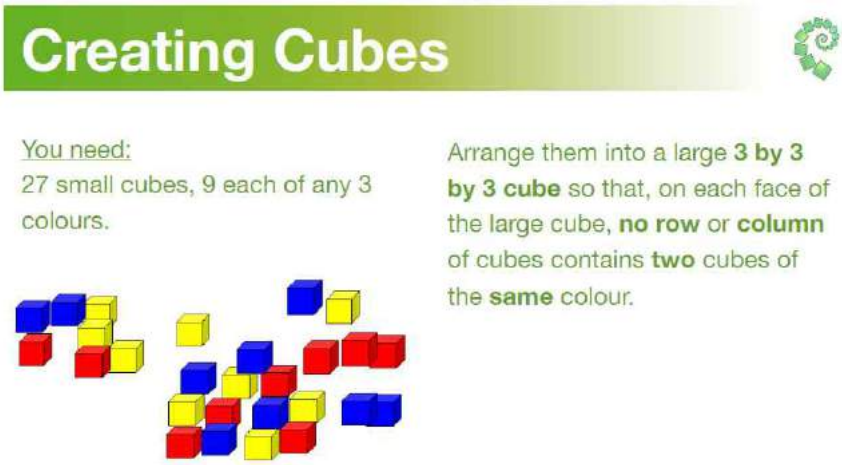
· 27 small joinable cubes, 3 of each colours

Ⅳ. Program Overview

	Topics	Time(min.)
1	Creating Cubes(Cube Sudoku)	30min.
2	$3\times3\times3$: Nine-Colour Cube	60min.

Ⅴ. Procedures

Activity1 : Creating Cubes(Cube Sudoku)



· Problem : Arrange nine red cubes, nine blue cubes and nine yellow cubes into a large 3 by 3 cube. No row or column of cubes can contain two cubes of the same colour.

· Materials : 27 small joinable cubes, 3 of each colours.

· Possible approach : You can lead up to this challenge by starting with a cube using two colours first. Having plenty of interlocking cubes available for children to try out their ideas will be essential. You could also begin by asking children if they think it is possible to create a cube with no two colours in the same row or column, using questions such as "I wonder ...? or 'Could I ...?'

· Key Questions : ① How could you start the cube?

② Is there only one way of doing it?

③ Have you all got the same solution?

④ Are some of the solutions similar?

· Possible extension : Some children will be able to explain how they solved the problem. You could ask them to predict and then test if this is possible for a larger cube.

Activity2 : $3\times3\times3$: Nine-Colour Cube

Nine Colours

You have 27 small cubes, 3 each of nine colours.

Can you use all the small cubes to make a 3 by 3 by 3 cube so that each face of the bigger cube contains one of each colour?

· Problem : If you have 27 small cubes, 3 each of nine colours, can you make a 3 by 3 by 3 cube so that each face of the bigger cube contains one of every colour?

· Materials : 27 small joinable cubes, 3 of each colours.

· Possible approach : On a Rubik's cube, the challenge is to make each face a single colour. Today we're going to do the opposite of that, and build a cube where every face has nine different colours showing. Alternatively, they could work on squared paper, isometric paper. Give students plenty of time to work on the challenge in pairs. While they are working, listen to their conversations and share with the whole class any useful realizations and noticing.

· Key Questions : Some of the 27 cubes have faces that are invisible from the 'outside' of the large cube.

① How many cubes have no 'visible' faces?

② How many cubes have one face visible?

③ How many cubes have two faces visible?

④ How many cubes have three faces visible?

⑤ If one colour appears in a corner, where will the other two cubes of the same colour need to appear?

⑥ There will be a cube in the centre. Where else will cubes of that colour need to be positioned?

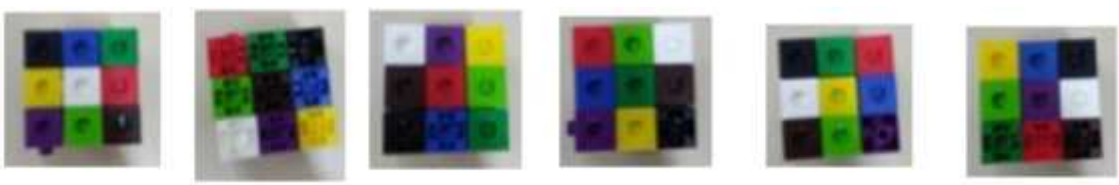
· Solution(example) : a simple and very neat way of making the cube from Ikroop and Wan from Maple Leaf Foreign Nationals School in China.

First we put 3 colours in a group because we thought it would be easier.

Next we made rods of 3 blocks. Each rod had 1 of its group's colours. We had to make sure the colours in each rod were in a different order.

Afterwards we took one rod of each colour group and connected them to make a square. We did this with the remaining rods, making three squares. We did not flip or rotate the rods, but connected them strategically, making sure that the rods of each colour group were ordered differently in each square.

Lastly we stacked all the squares, one on top of the other. When we finished, our cube had 1 of every colour in each face!



· Activity Sheet :

3×3×3 Nine-Colours

How many blocks are in a 3×3×3 cube and How many sides of blocks do you see?

Problem.

1. Using 27 small cubes, 3 each of nine colours, try to make a 3 by 3 by 3 cube so that each face of the bigger cube contains one of every colour.

Think Think~!

1. How many cubes have no 'visible' faces?

2. How many cubes have one face visible?

3. How many cubes have two faces visible?

4. How many cubes have three faces visible?

5. If one colour appears in a corner, where will the other two cubes of the same colour need to appear?

6. There will be a cube in the centre. Where else will cubes of that colour need to be positioned?

Draw and Explain your 3×3×3 cube.

Explain how you completed your Nine-Colour Cube.

· Possible extension : Painted Cube, Partly Painted Cube, and Marbles in a Box all require similar three-dimensional thinking.

VI. Preferences

1. NRIch, University of Cambridge. https://nrich.maths.org/1027/note
2. Wikipedia, https://en.wikipedia.org/wiki/Nine-Colour_Cube
3. Rubik's Cube Variants, Jaap's Puzzle Page
4. Nine Color Scramble Cube, Twisty Puzzles Museum

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Straight and reflection of light

Sunny Lee / Daniel Sungura esunny21@hanmail.net

Notice 1. How to Understand Light : **ray tracing**

Ray tracing is a technique to understand the phenomenon of geometric optics. This is based on a model for the behavior of light in which we envision light being either emitted in all directions by a luminous object (such as a light bulb)

Notice 2. The teaching method : PI (peer instruction)

Peer Instruction: Teaching method by Eric Mazur, a professor of physics at Harvard University

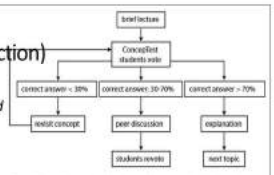
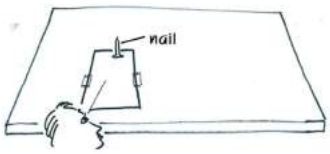


Fig. 1. The peer instruction implementation process. Note that the recommended percentages of correct answers for each step are estimates—how an instructor decides to proceed is highly dependent on the content and student population.

Activity 1. Viewing the object

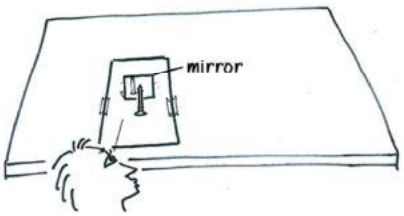
Describe the process of seeing an apple in picture. Use the arrows to show the direction of progress of light.

Activity 2. The method of parallax: Positioning an object



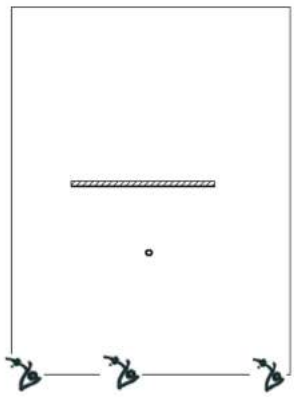
What is the minimum numbers of lines required to determine the position of the nail?

Activity 3. The method of parallax: Positioning the image



Draw a line toward the image in the mirror.
Where is 'the image of the nail'.?

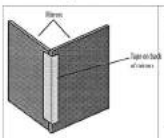
Activity 4. Understanding the Law of Reflection by using Ray Tracing



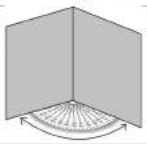
Draw a line toward the image in the mirror.
Think about the direction of light. Draw an arrow.
Where did the light come from?
- In the mirror? - From the object? - Or else?
Express the path of light by connecting eyes, images, and objects with arrows.

Based on the lines that we drew so far, can you tell what principle is followed when the light reflects from a mirror?

Activity 5. Number of images between two mirrors



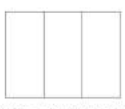
1) Put the tape on the back and sides of the two mirrors like a book binding



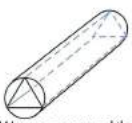
2) Place the book mirror on a protractor.

3) Record the angle of the mirror and the number of images in the mirror.

number of images	2	3	4	5	6	7
range of angles						



Make a triangular prism of three rectangular mirrors and tape them(reflector faces inward).



Wrap paper around the triangular to make it strong. Decorate a it with pictures

A glass bead can be put on one side of the column or a transparent decorative plate can be attached.

05. Straightness and reflection of light

Lee Sunny

Ⅰ. Introduction and Background

This class deals with the definition of light source, the straightness and reflection of light as a starting point of learning about light. The teaching method will be a PI (peer instruction). Rather than teachers, it is easier for students to understand when friends teach them. And because the mistakes are revealed in the process of explaining the wrong answers, the opinions converge in the answers. The flow of PI class is basically in the order of mini-lecture, concept test, voting, peer discussion, revoting, confirmation(Mazur, 1997).

The concept tests are very important in PI teaching method. An effective concept test induces cognitive conflict, promotes discussion with peers, and forms the right concept in the process of resolving conflicts.

Ray diagram will be used in Mini-lectures, and it'll visualize the progress of light. This is the application of the method used by the professor McDermott of the University of Washington in the Tutorial. In addition, the conceptual test items are based on the research of Professor Kim, Jung - Bok's team.

In the process of the lesson, I hope that the concepts are well organized. Also, I want you to discuss a lot.

Ⅱ. Learning Objectives

· explain the principle of viewing objects.

· understand and explain the principle about an image, which is made by a plane mirror.

Ⅲ. Materials

(Large head) nails, PC mirror, laundry clip (to stand mirror), B4 paper, tape (hold paper), short ruler, pen

Ⅳ. Hazards and Safety

· Trim or tape the edges of the PC mirror so that student's hands are not hurted.

· When pointing to the position of the nail with your fingers, be careful not to be stabbed.

Ⅴ. Program Overview

order	Activity Topics	Time(min)
1	Activity 1. Viewing the object	20
2	Activity 2. The method of parallax : Locating an object	30
3	Activity 3. The method of parallax : Locating an images	50
4	Activity 4. Understanding the Law of Reflection by using Ray Tracing	

VI. Procedure

Activity 1. Viewing the object

- Describe the process of seeing an apple in picture. Use the arrows to show the direction of progress of light.

Lesson Tips

◦ Students often draw arrows directly from the eyes. They actually think they directly see objects. But we can not see objects without the aid of light. Learn that light from the object enters our eyes and recognizes the object, and that light starts from the light source.

◦ Rather than explaining things in one by one, we are going to look at the pictures from our friends together. Students easily reach the correct answer by looking at a friend's painting. It is better lesson to let students realize rather than unilaterally teach.

◦ Concepts are created in the process of expressing one's thoughts (expectation), comparing them to those of others (observation), and finding the answers (explanation).

◦ After class, organize the following items.

1 Light travels in a straight line

(1) *Light source* : A light-emitting object 예 Laser, Sun, Firefly

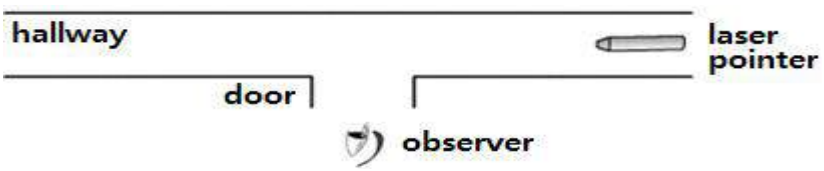
(2) *straight* of Light : The light from the light source goes straight in all directions

2 The process of seeing objects

(1) Looking at an object means that *Light* enters *the eye*

(2) Light enters the eye from the light source or *reflected* from the object.

An observer in the classroom is looking into the hallway. I shot a laser pointer from one end of the corridor toward the other. Can the observer know if the laser pointer is on or off?



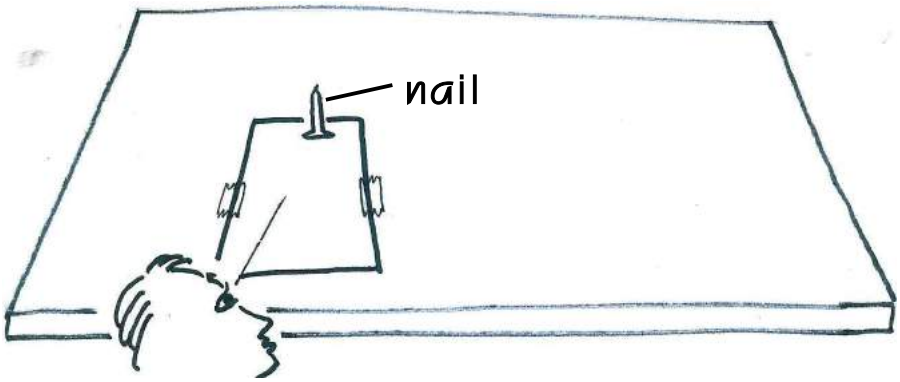
① Able to know. ② Unable to know. reason: _____

Activity 2. The method of parallax : Locating an object

Materials : (Large head) nail 1ea, B4 paper, tape (hold paper), short ruler, pen

Procedure

A. This experiment is a team of two people. First, one person close one eye and lean down so that your open eye is at table level. The other person sets a nail on the table.

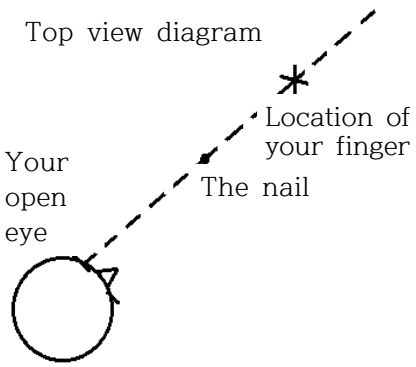


Hold on finger above the table (more than 15cm) and then move your finger until you think it is directly above the nail. Move your finger straight down to the table and check whether your finger is, in fact, directly above the nail.

Try this exercise several times, with your partner setting the nail at different locations. Keep your open eye at table level. After several tries, exchange roles with your partner. (☞When you point the nail, be careful not to stabbed to the end of the nail.)

How can you account for the fact that when your finger misses the nail, your finger is always either in front of the nail or behind it, but never to the left or right of the nail.

B. Suppose that you placed your finger behind the nail (as shown at right) while trying to locate the nail.
Predict whether your finger would appear to be located *to the left of, to the right of, or in line with* the nail if:



- you moved your head to the left.

- you moved your head to the right.

Check your predictions. Resolve any inconsistencies.

C. Suppose that you had placed your finger in front of the nail rather than behind it. Predict whether the nail or your finger would appear on the left when you move your head to the left. Check your answer experimentally.

D. Place a large sheet of paper on the table. Stand a nail vertically at one end of the piece of paper.

Place your eye at table level at the other end of the piece of paper and look at the nail. Use a straightedge to draw ***a line of sight*** to the nail, that is, a line from your eye to the nail.

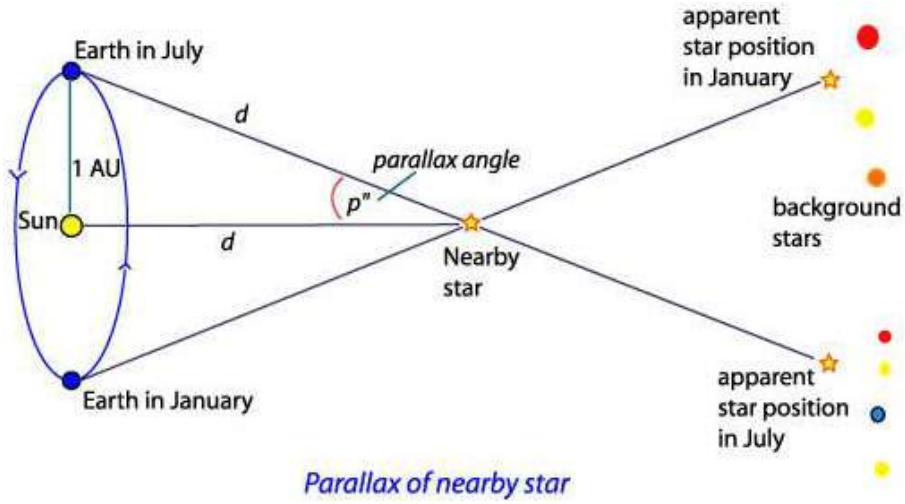
Repeat this procedure to mark lines of sight from three other very different vantage points, ***then remove the nail***

How can you use these lines of sight to determine where the nail was located?

What is the smallest number of lines of sight needed to determine the location of the nail?

Result and Conclusion

※The viewing position alters the direction towards the object. This difference is called parallax. We can devise for locating an object as the *method of parallax*. Due to the Earth's orbit, the star's parallax occurs, and the star's position can be determined by using this.



Parallax of nearby star

image source: https://socratic.org/questions/what-is-a-parallax-error

Activity 3. Image location

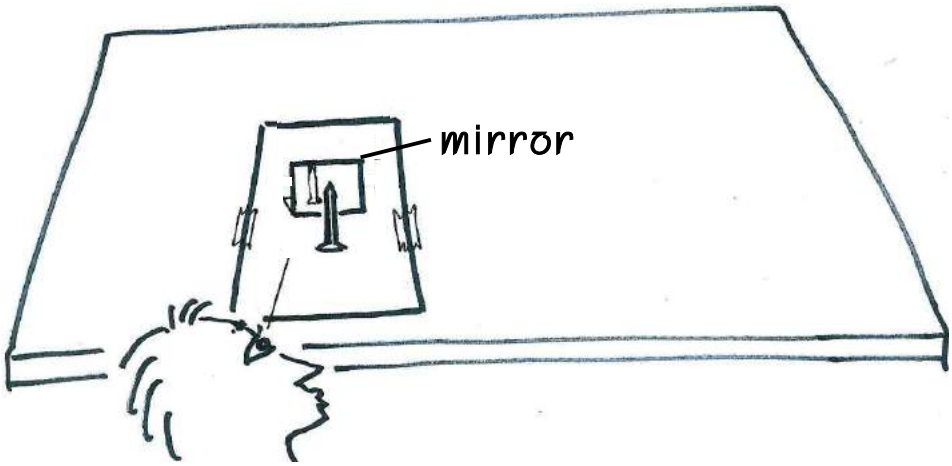
Materials : (Large head) nails 2ea, PC mirror, laundry clip (to stand mirror), B4 paper, tape (hold paper), short ruler, pen

Procedure

Obtain a small mirror and two identical nails. Place the mirror in the middle of a sheet of paper. Stand one nail on its head about 10 cm from the front of the mirror. We will call this nail the ***object nail.***

On the paper, mark the locations of the mirror and object nail.

A. Place your head so that you can see the image of the nail in the mirror.
Use the method of parallax to position the second nail so that it is located in the same place as the image of the object nail. Mark this location on the paper.



Is **the image of the nail** located ***on the surface of, in front of, or behind*** the mirror?

Would observers at other locations agree that the image is located at the place you marked? Check your answer experimentally.

B. Move the nail off to the right side of the mirror as shown. Find the new image location.

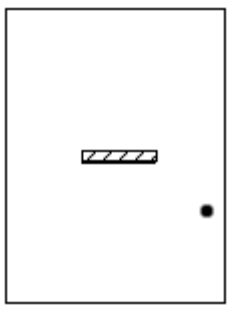
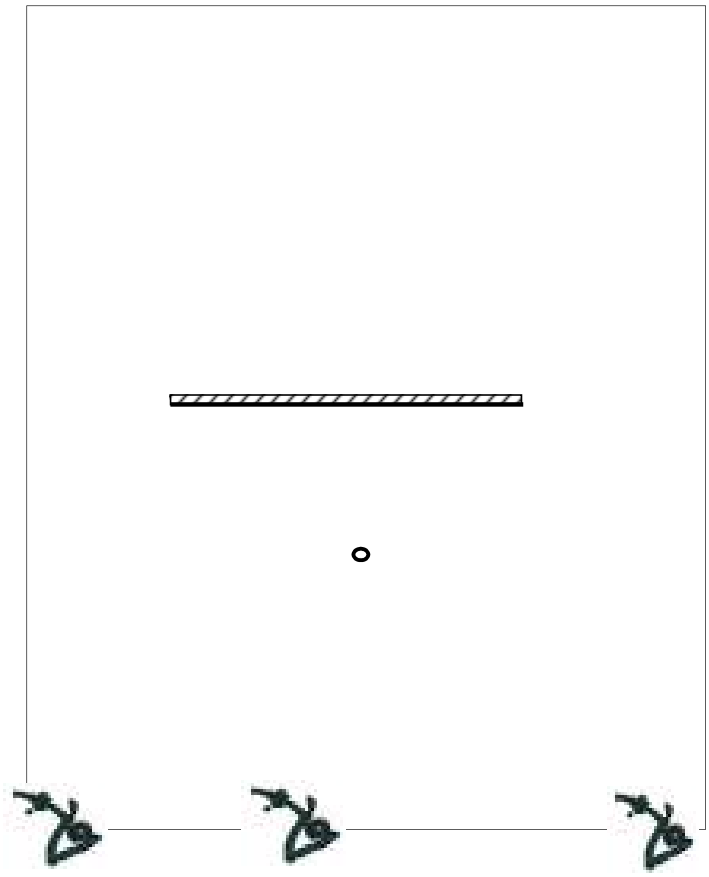


Fig.7 Mirror and nail

Q) What is the minimum size of a mirror required when a 180 cm tall person sees his whole body?

Activity 4. Understanding the Law of Reflection by using Ray Tracing

Imagine the process of light from an object enters my eyes through a mirror.
The light from the object to the mirror and from the mirror to my eyes. What is the relationship between these two? Let's look at the relationship of the two by tracking the path of light.



A. Turn the large sheet of paper over. Place the mirror in the middle of the sheet of paper, and place a nail in front of the mirror. On the paper, mark the locations of the mirror and the nail.

On the paper, draw several lines of sight to the ***image*** of the nail.
How can you use these lines of sight to determine the location of the image of the nail?

Use the method of parallax to determine the location of the image of the nail.
Do these two methods yield the same location of the image (to within reasonable uncertainty)?

B. Remove the mirror and the object nail. For each eye location that you used in part A, draw the path that light takes from the object nail to the mirror.
Draw an arrow head on each line segment (→—) to indicate the direction that light moves along that part of the path.
On the basis of the paths that you have drawn, formulate a rule that you can use to predict the path that light takes after it is reflected by a mirror.

C. Place the second nail at the location of the image of the object nail. Draw a diagram illustration the path of the light from that nail to your eye for the same eye locations as in part B.

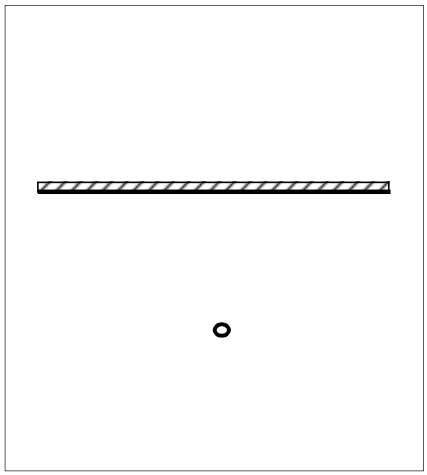
How is the diagram for this situation similar to the diagram that you drew in part B?

Is there any way that your eye can distinguish between these two situations?

An application of ray tracing

Use a straightedge and a protractor to draw rays as accurately as possible.

A. On the diagram at right, draw one ray from the pin that is reflected by the mirror
From one ray alone do you have enough information to determine the location of the image?



B. On the diagram above, draw a second ray from the pin that is reflected by the mirror and that would reach an observer at a different location.
What can you infer about the location of the image from this second ray alone?
How can you use the two rays that you have drawn to determine the location of the image?
Is there additional information about the image location that can be deduced from three or more rays?

C. Determine the image location using the method of ray tracing. (If it is necessary to extend a ray to show from where light appears to come, use a dashed line.)
Does the light that reaches the observer actually come from the image location or does this light only appear to come from that point?
What is the smallest number of rays that you must draw in using ray tracing to determine the location of the image of an object?
How does the distance between the mirror and the image location compare to the distance between the mirror and the pin?

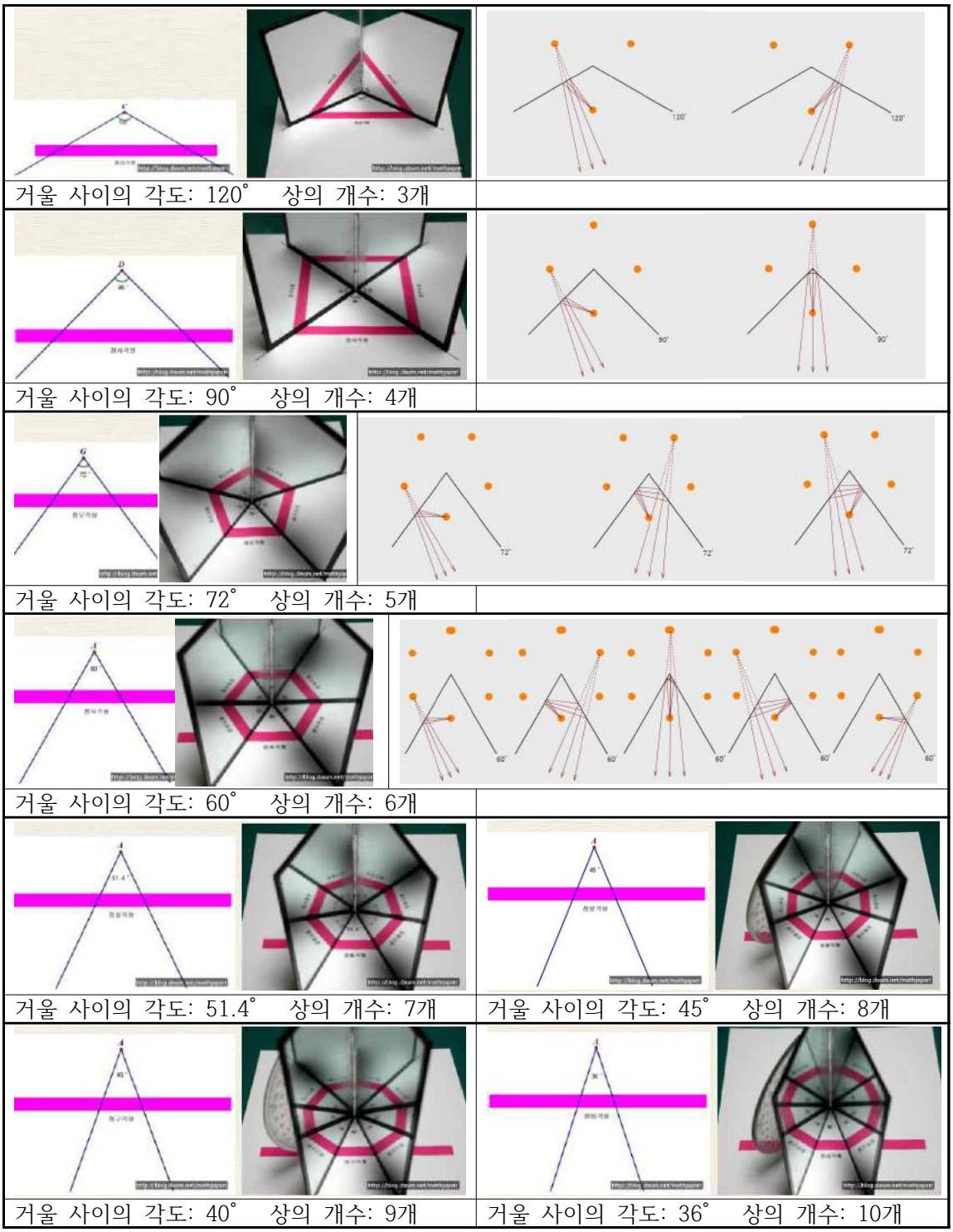
The diagram that you drew above to determine the image location is called a ray diagram. The point from which the reflected light appears to come (i.e., the location of the pin that you saw when you looked in the mirror) is called the image location. An image is said to be virtual when the light that forms the image does not actually pass through the image location. An image is said to be real when the light that forms the image does pass through the image location.

When drawing ray diagrams, use a solid line with an arrow head (→—) to represent a ray, that is, a path that light takes. Use a dashed line (- - - - -) to extend a ray to show from where light appears to come in order to distinguish such a line from an actual ray.

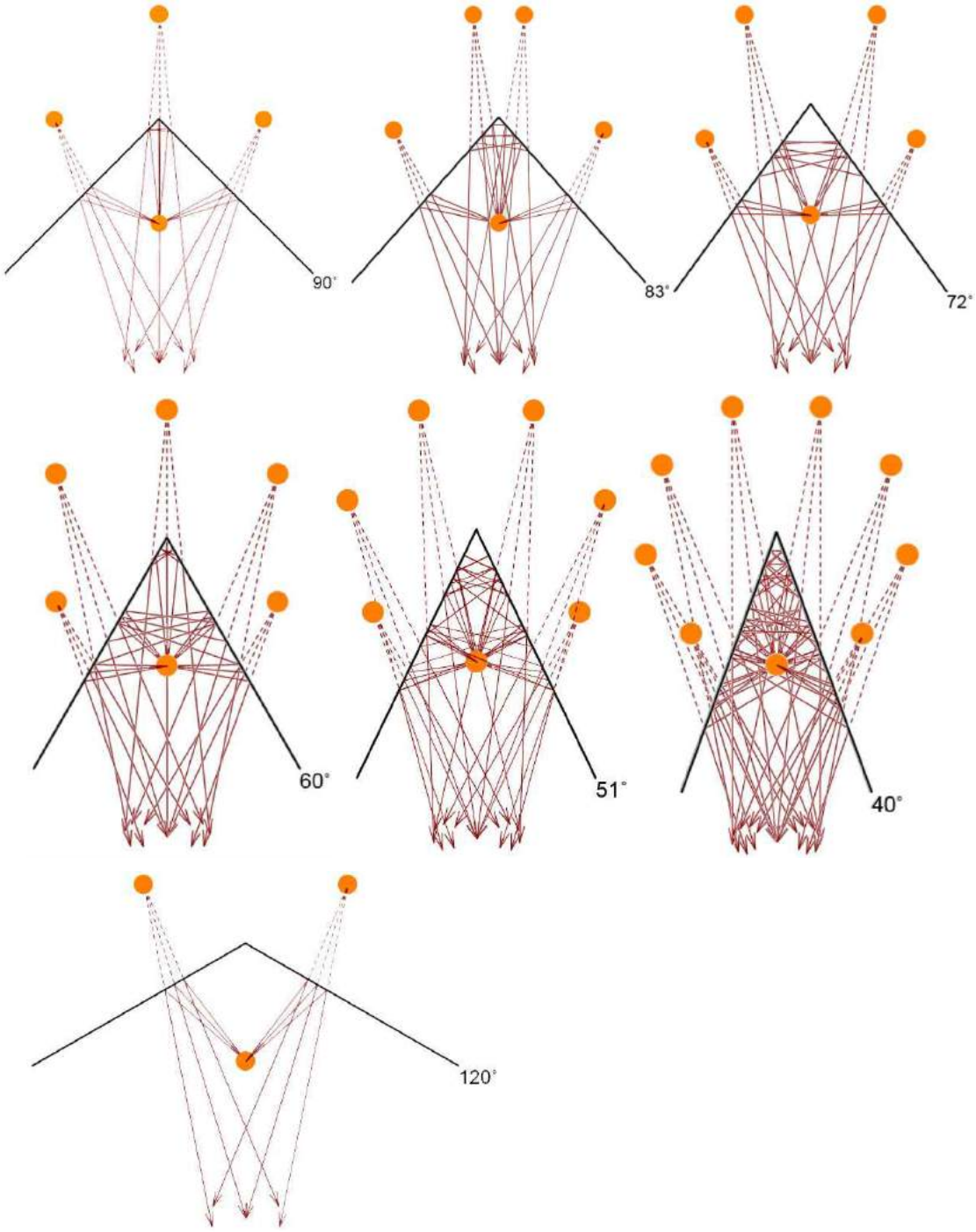
Lesson Tips

◦ Many students mechanically learn the "incident angle = reflection angle". It is difficult to extend the thinking with this learning method. The ray tracing method is useful for embodying the concept of light by reaching comprehensive thinking through specific processes.

Activity 5. Making Kaleidoscope: Number of images between two mirrors



http://blog.daum.net/mathjapari/38



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McDermott, L. C. & Shaffer, P. S. (2002). Tutorial in Introductory Physics
http://javalab.org/multiple_reflections/

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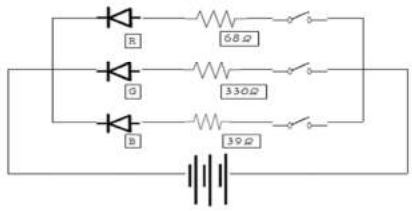
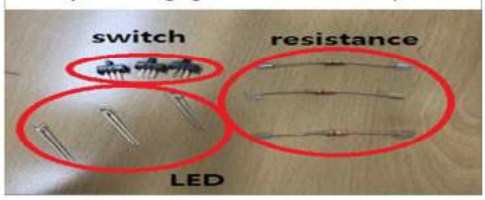
Let`s make chameleon Table tennis ball

Sang Hee Chun/ Mtafya Jickson iris6883@naver.com

Activity 1. Drawing a circuit diagram of a light mixing device.



Activity 2. Making light mix device circuit yourself.



Activity 2. Making light mix device circuit yourself.

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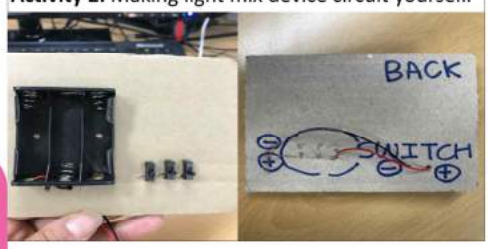

Activity 2. Making light mix device circuit yourself.

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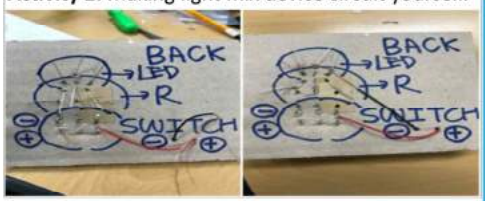


Activity 2. Insert the batteries, turn on the switches.

Results. turn on two LEDS

BLUE+GREEN RED+BLUE

Results. turn on two or three LEDS

GREEN+RED RED+GREEN+BLUE

Workout.

1) let's draw a circuit diagram that you have designed through discussions with your friends.
2) Let's turn on more than two LEDs and write down what color is represented.
3) Is it equal to theoretical color?
4) If not, why?
5) How do we get the same color as the theoretical experiment?

06. Let`s make chameleon Table tennis ball

chun sanghee

Ⅰ. Introduction and Background

When we superimpose red, green, and blue light, we make the color of the most branches, and these three are called the three primary colors of light.

When the light of red and green is overlapped, yellow appears. When the light of red and blue is overlapped, magenta appears. and when green and blue are overlapped, blue green appears. Of course, when red, blue, and green all overlap, white appears.

When you make white by overlapping two colors, they are called complementary colors. If you subtract any color from the white light, the remaining color becomes complementary color.

Ⅱ. Learning Objectives

· A circuit diagram of the light synthesizer can be constructed and manufactured directly.

· Through the light synthesizer, you can create various colors with three primary colors of light.

Ⅲ. Materials

· Thick paper, Battery holder, AA Battery ×3 , coin cell holder, LED(Red, Green, Blue), resistance(39Ω, 68Ω, 330Ω), switch ×3, awl, pliers, Cellophane tape

Ⅳ. Hazards and Safety

Be careful not to get caught in a sharp wires.

Ⅴ. Program Overview

Procedure	Activity Topics	Time required (minutes)
1	Drawing a circuit diagram of a light mixing device	30분
2	Making light mixing device circuit yourself	50분
3	Learn to mixing the light through a light mixing device	20분

Ⅵ. process

Activity 1 : Drawing a circuit diagram of a light mixing device

- Draw a circuit to configure the light mixing device unit with a given material.
- Three LEDs can be turned on and off with each switch

material: Thick paper, Battery holder, AA Battery ×3 , coin cell holder, LED(Red, Green, Blue), resistance(39Ω, 68Ω, 330Ω), switch ×3, awl, pliers, Cellophane tape

hint1) Red, green and blue LEDs are given one by one and LEDs must be connected in parallel.

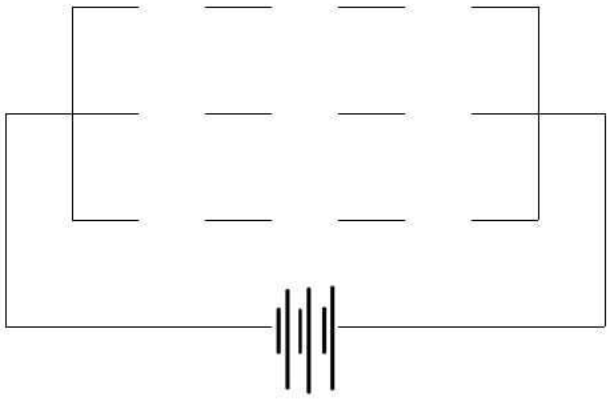
hint2) LEDs have (+) and (-). It should be distinguished.

hint3) Red LEDs and 68Ω resistance, green LEDs and 330Ω resistance, blue LEDs and 39Ω resistance should be connected in series connection.

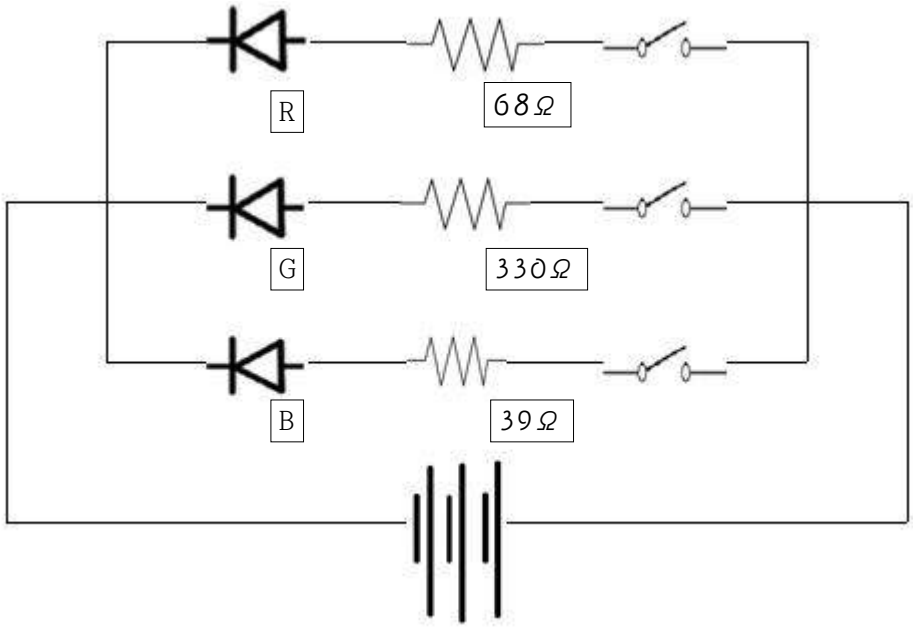
First, let's draw a circuit diagram that you have designed through discussions with your friends.

- wire:
- Battery:
- resistance:
- LED:
- switch:

hint4) Let's draw the appropriate electrical material for the circuit diagram below.



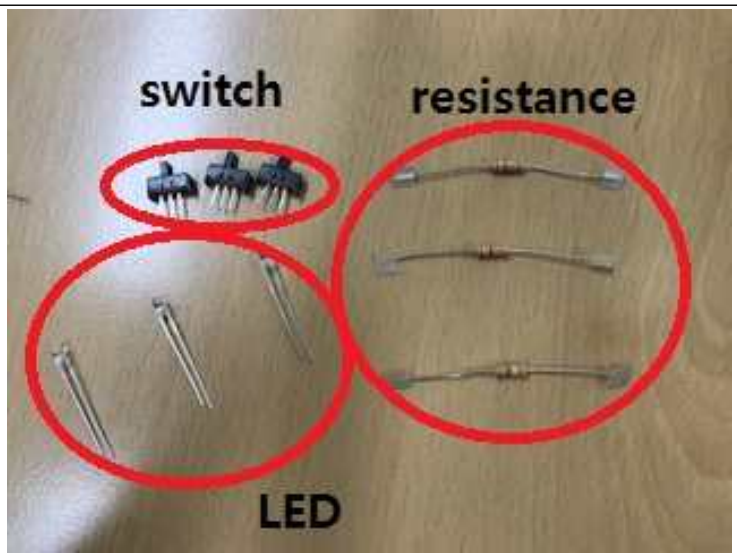
Summary of results) Compare it to your own circuit diagram



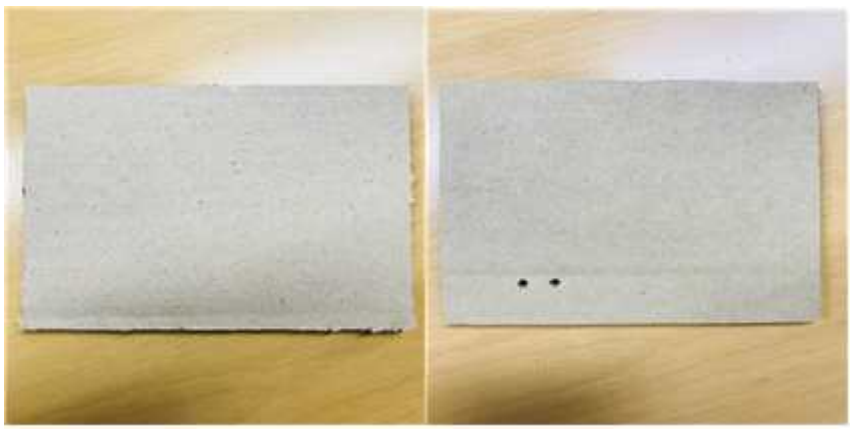
Activity 2 : Making light synthesis device circuit yourself

Making light synthesis device circuit yourself

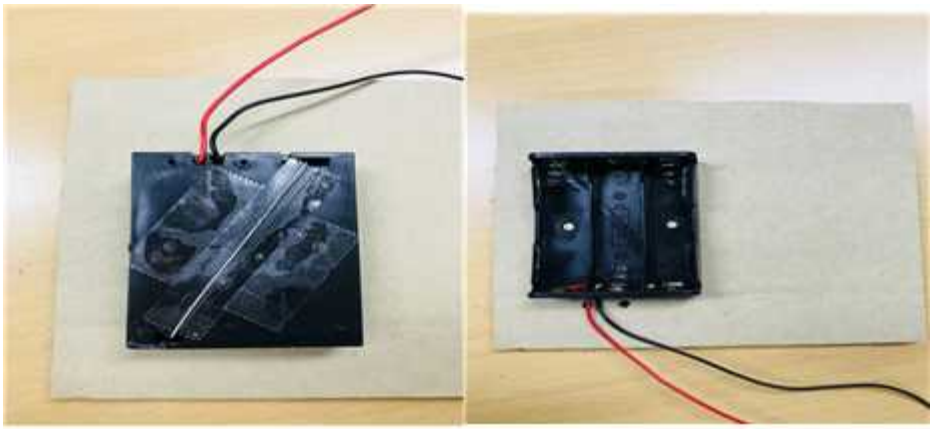
Materials: Thick paper, Battery holder, AA Battery ×3 , coin cell holder, LED(Red, Green, Blue), resistance(39Ω, 68Ω, 330Ω), switch ×3, awl, pliers, Cellophane tape₩



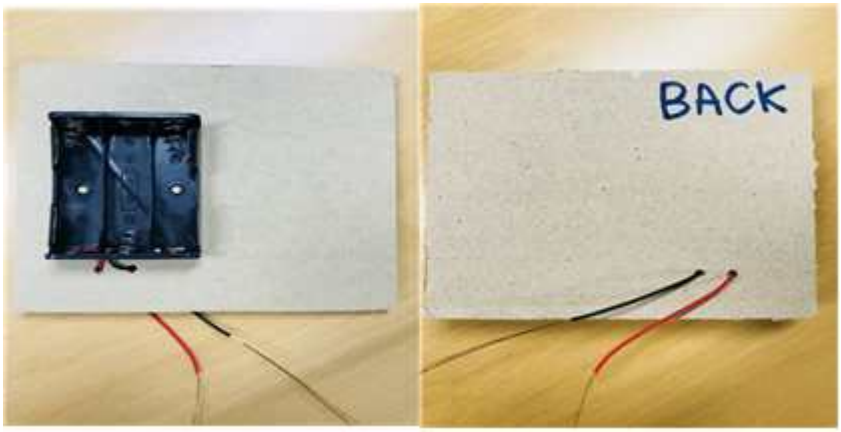
1. Prepare to cut thick paper with 10cm width and height.
2. Drill a hole in a thick sheet of paper to insert two electrical wires.



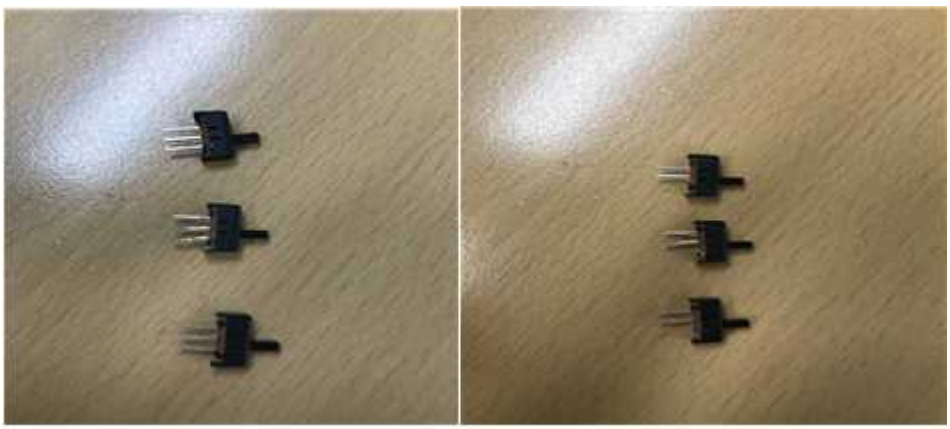
3. Attach a double-sided cellophane tape to the back of the battery holder and attach it to the top of the two punched holes in the paper.



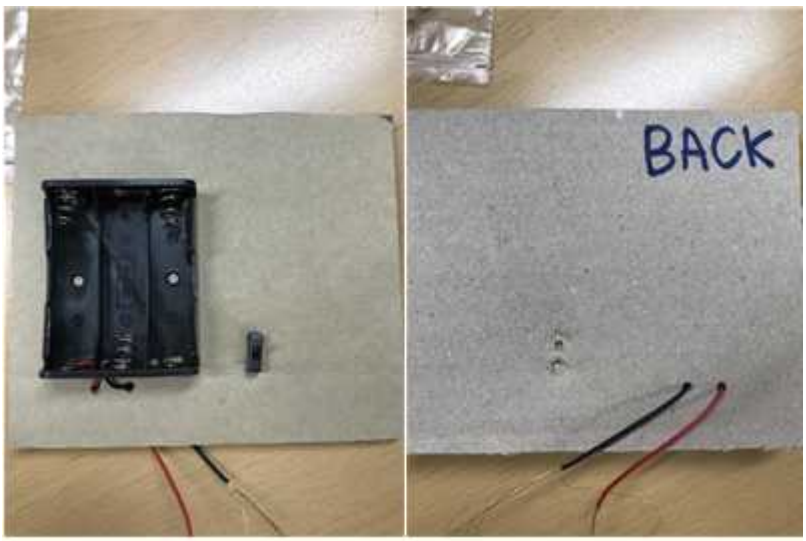
3. Put the wires in two holes and send them back.



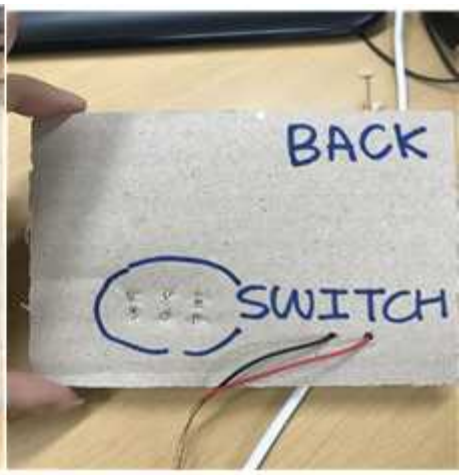
3. Prepare the switch. The lowest wire on the switch is bent to the left.



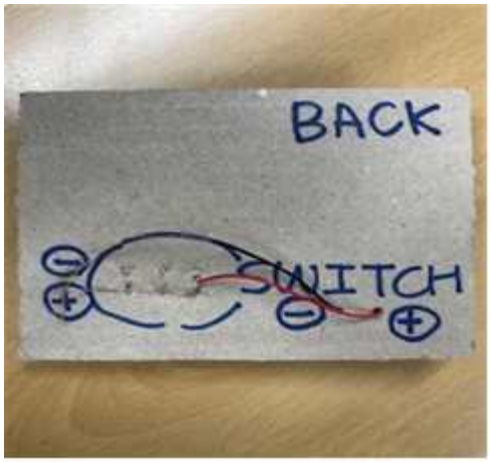
4. On the right side of the battery holder, drill two holes through which the switch wires can be inserted, and fix the switch.



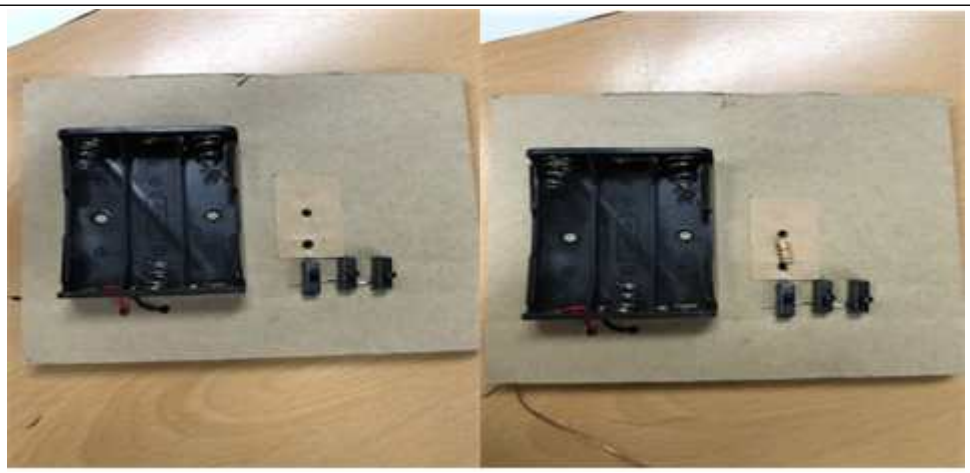
5. Put the three switches in the same way.



6. Connect by twisting the corresponding red (+) wire to the switch (+) wire.`

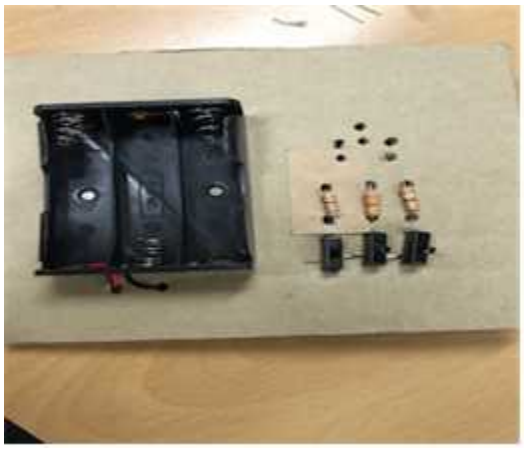


7. Drill a hole next to the battery holder to insert the resistance.(The resistance are arranged in the order of 68 Ω, 330 Ω, and 39 Ω according to the LED sequence.) (The hole is drilled in consideration of the length of the electric wire in the battery.)

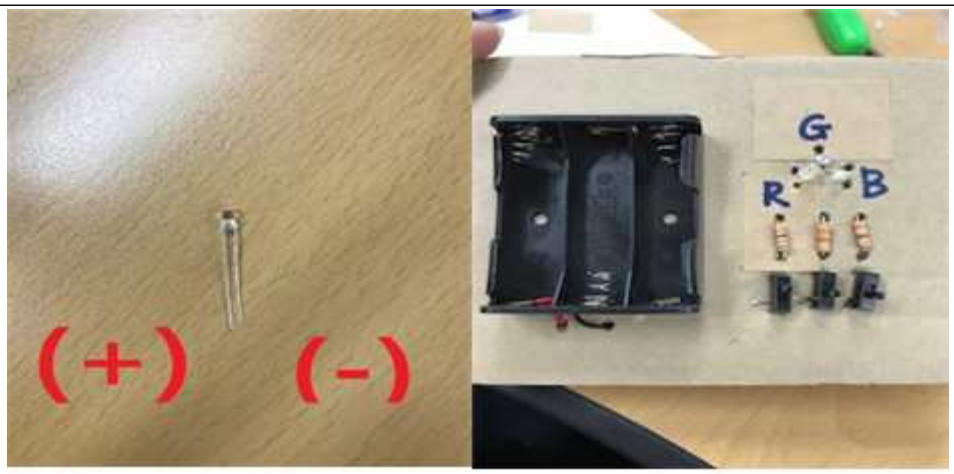


8. Connect the (-) of the switch to the resistor wire. (Be careful not to short-circuit because it is not soldered.)

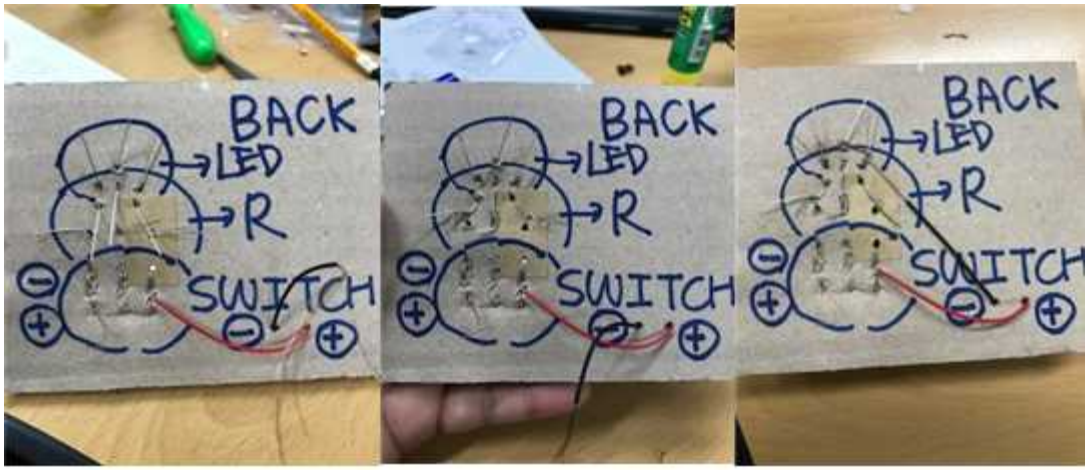
9. Drill the hole to insert the LED. (The red LED, green LED, blue LED become the three vertices of the triangle.)



10. Connect the LEDs in order of red, green and blue. (When LED is connected, distinguish between (+) and (-).)

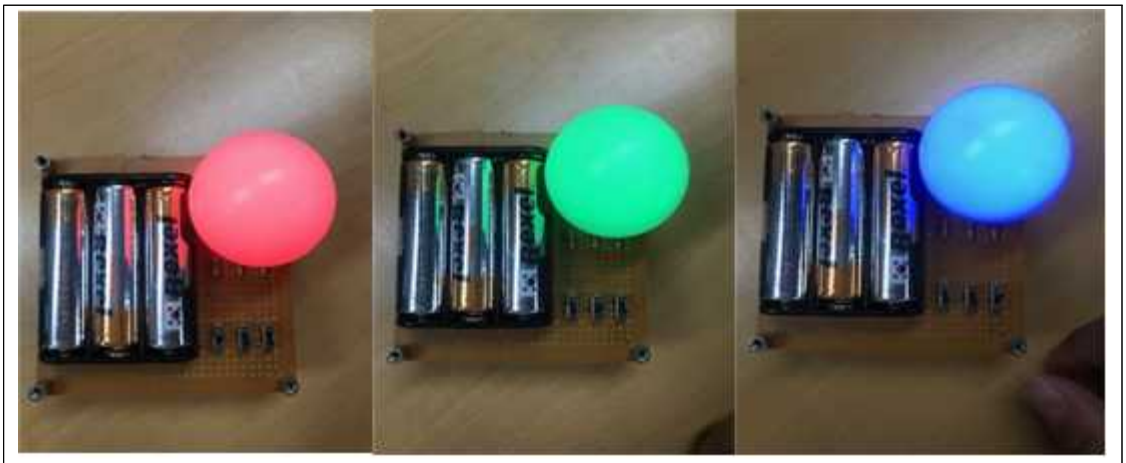


11. Connect the LED(+) and the resistance, the LED(-) and the (-) of battery holder. (Be careful not to short-circuit because it is not soldered.)

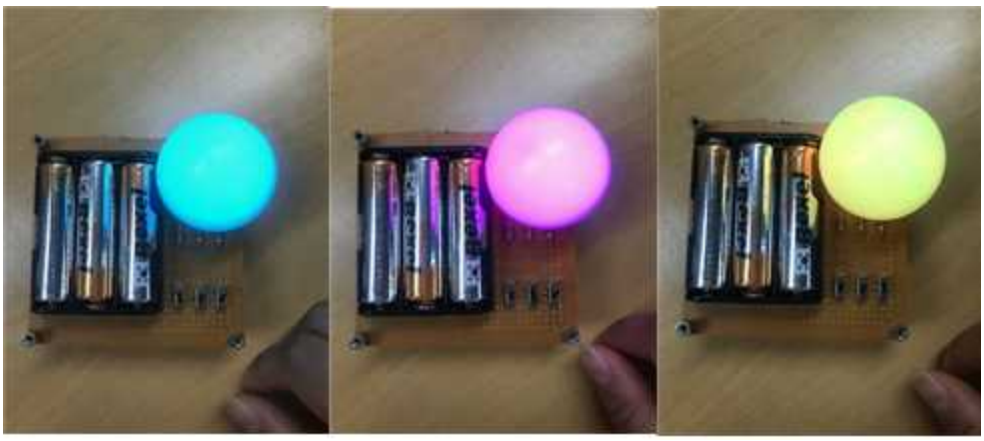


12. Insert the batteries and turn on the switches one by one.

13. Put a table tennis ball and turn on the LEDs one by one.



14. Turn on two LEDs.



15. Turn on all three LEDs.

Ⅶ. workout

(1) let's draw a circuit diagram that you have designed through discussions with your friends.

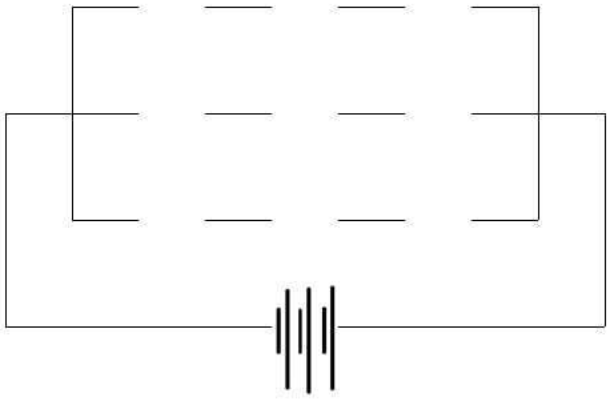
wire:

Battery:

resistance:

LED:

switch:



(2) Let's turn on more than two LEDs and write down what color is represented.

- R+G=
- G+B=
- R+B=
- R+G+B=

(3) Is it equal to theoretical color?

(4) If not, why?

(5) How do we get the same color as the theoretical experiment?

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Refraction and Polarization of light

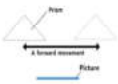
H.K. Kim / gusrud916@naver.com

Activity 1 Prism & Refraction

STEP 1.

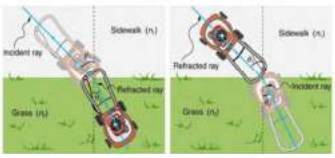
STEP 2.

STEP 3.



Noctice 1 Refraction

1. Refraction

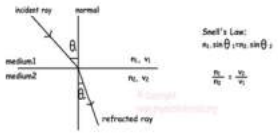


2. Index of refraction n

$$n = \frac{c}{v}$$

v = speed of light in the material
c = speed of light in a vacuum

3. Law of Refraction

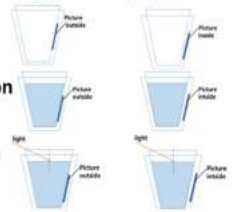


Activity 2 A disappearing picture

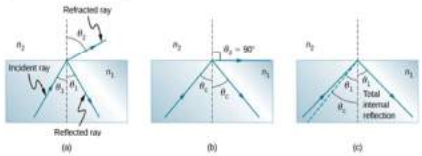
STEP 1. Making

STEP 2. Observation

STEP 3. Expression



Noctice 2 Total Internal Reflection



Critical Angle
The incident angle θ_1 that produces an angle of refraction of 90° is called the critical angle, θ_c.

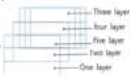
Activity 3 Polarization

STEP 1. Observation

Overlap and rotate slowly

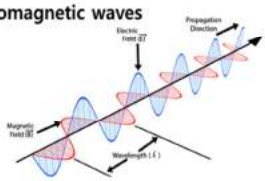
STEP 2. Making & Observation

1. Overlapping
2. Add the two more sheets to the last OPP tape
3. Place between crossed polarizers & Rotate



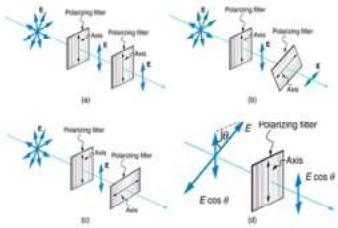
Noctice 3 Polarization

1. Electromagnetic waves

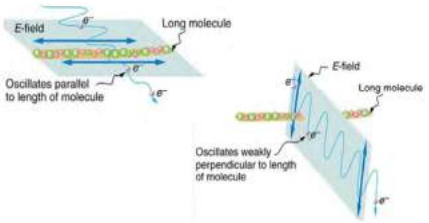


The direction of polarization of an EM wave is defined to be the direction of its electric field.

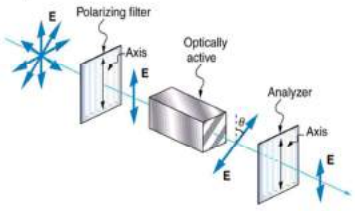
2. Polarization



2. Polarization



3. Optically active



07. Refraction and Polarization of light

Kim Hyunkyung

Ⅰ. Introduction

When light hits an obstacle, it is absorbed, bounced, and passed. In particular, if the obstacle is as transparent as water or glass, then light flows through it, which changes the speed of the light. Light that is inclined to the interface of a transparent barrier causes the speed difference in each material to deflect the direction in which it is directed, this is called refraction. Desert and polar mirages are caused by the refraction of light. In this experiment, we will experience the direction in which light moves according to the type of matter, and we will use a prism to discuss the direction in which light will proceed and how it will be formed.

We want to look at polarization and understand that light is electromagnetic radiation. Let's experience what is caused by polarization and think about what it is used for.

Ⅱ. The aims of the lesson

· It is possible to explain the refraction of light according to the medium.
· You can find the direction of progress of light in a prism.
· Explore different phenomena for polarization.

Ⅲ. Preparedness

· Prism, picture(size of PRISM), laser pointer
· Paper cup, clear cup, printed paper with letters (or writing directly), nim pen, OHP film, cellophane tape
· Two polarized filters, petri dishes, OPP tape, PVC film

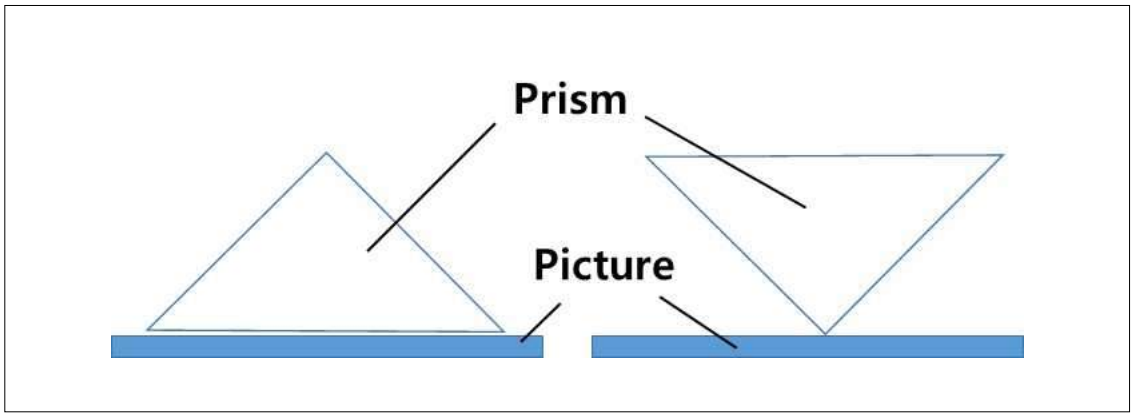
Ⅳ. Class overview

Sequence	Activity	Time required (minutes)
1	**Prism & Refraction**	30
2	**A disappearing picture**	35
3	**Polarization**	35

Ⅴ. Process

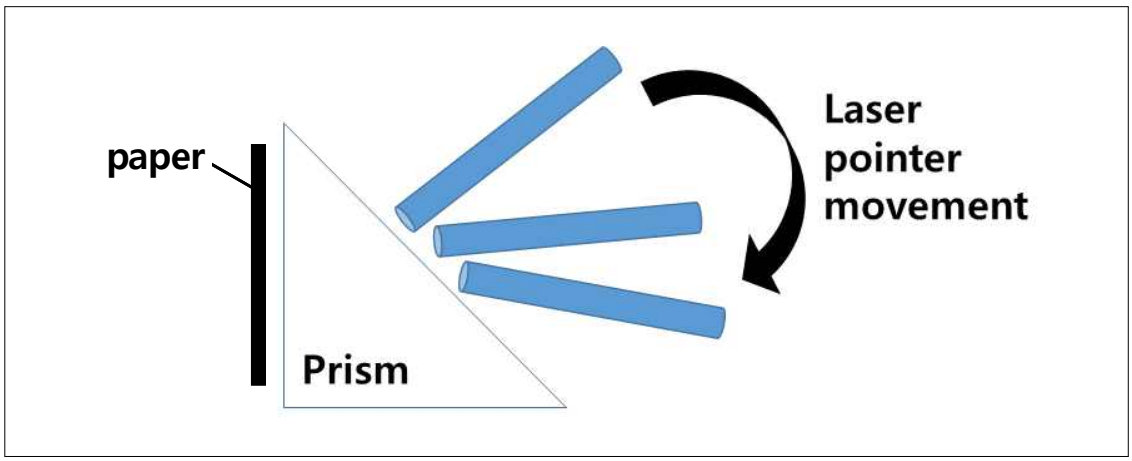
[Activity 1] See with Prism

1. Observation



step 1-①) Place the prism as shown in A and observe the picture.

step 1-②) Place the prism as shown in B and observe the picture.

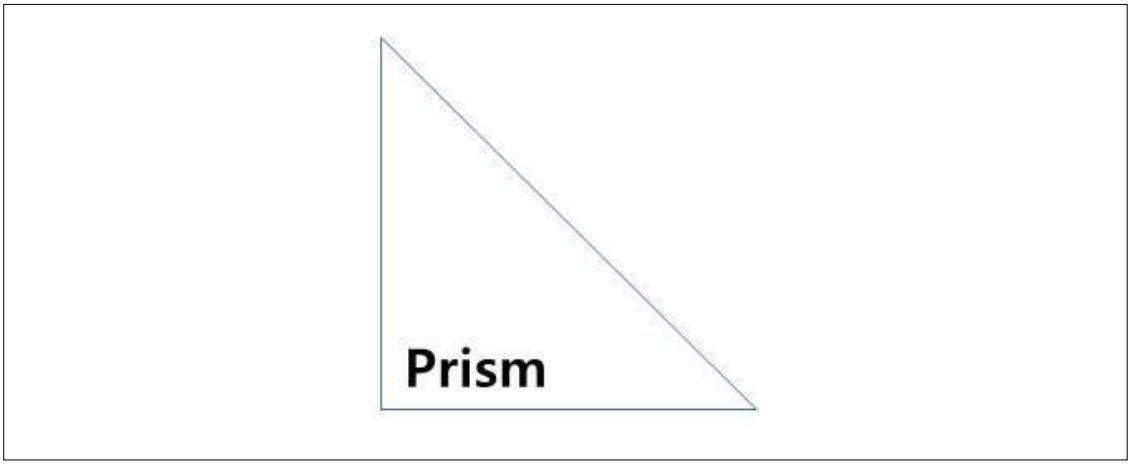


step 2) Set up a perpendicular prism to light up the laser pointer on one side and place a white paper on the other side. Watch as you change the angle between the laser pointer and the prism.

2. Result & Thinking

- Compare the observations of step 1-① and ② and explain the differences. Why do differences happen?

■ Draw the path of the laser light from the PRISM in step 2).



■ What rules can be found in step 2)?

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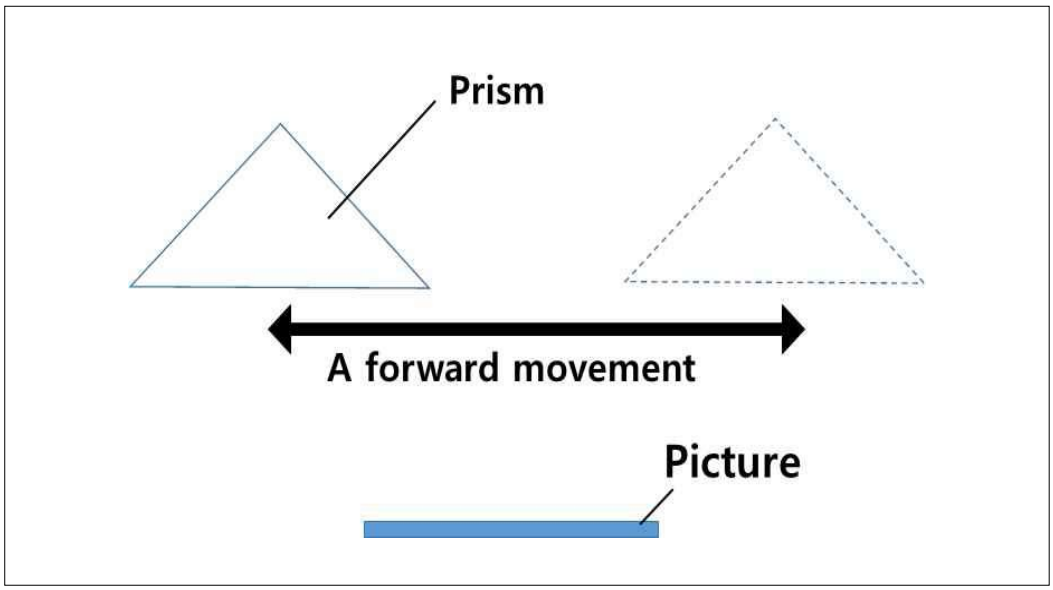
3. Application

1) Place each prism with its sharp point upwards and at a height of 10cm above the picture.
2) Move the PRISM to the left and right and observe the picture.



3) Which side is the picture seen through the prism? Why do they look that way?

[Activity 2] A disappearing picture

1. Observation

1) Attach the picture to the inside of the opaque cup. Prepare a transparent cup smaller than the opaque cup, and stack the two cups together. Pour water into clear cups about 2/3 full.

2) Pour water into a clear cup for two thirds of the time, and look inside the cup while looking at the picture at different levels of the eye.

3) Place a letter on the outer face of a clear cup smaller than the opaque cup and stack the two cups together.

4) Pour water into a clear cup for two thirds of the time, and look inside the cup while looking at the picture at different levels of the eye.

2. Result & Thinking

1) If you attach a picture to the inside of the opaque cup.

Water is not added to a clear glass.	Water in a clear glass

2) If a picture is painted on the outside of a clear cup

Water is not added to a clear glass.	Water in a clear glass

3) Compare the results of placing the letters on the opaque and transparent cups to discuss the differences between the two.

---

3. Application – Create a Secret Letter !!!

1) Prepare two 4 × 6 cm PVC film, a thick transparent cellophane tape, and a nim pen.
2) Write the letters on one PVC film and decorate it with a picture, etc.
3) Overlap the two PVC film together and attach a clear cellophane tape to the rim to prevent water from entering between the two PVC film.
4) Put the PVC film on the cellophane tape into the water cup. How does it look?
5) You can write on two exposures of each film to make a secret letter.

[Activity 3] Polarization

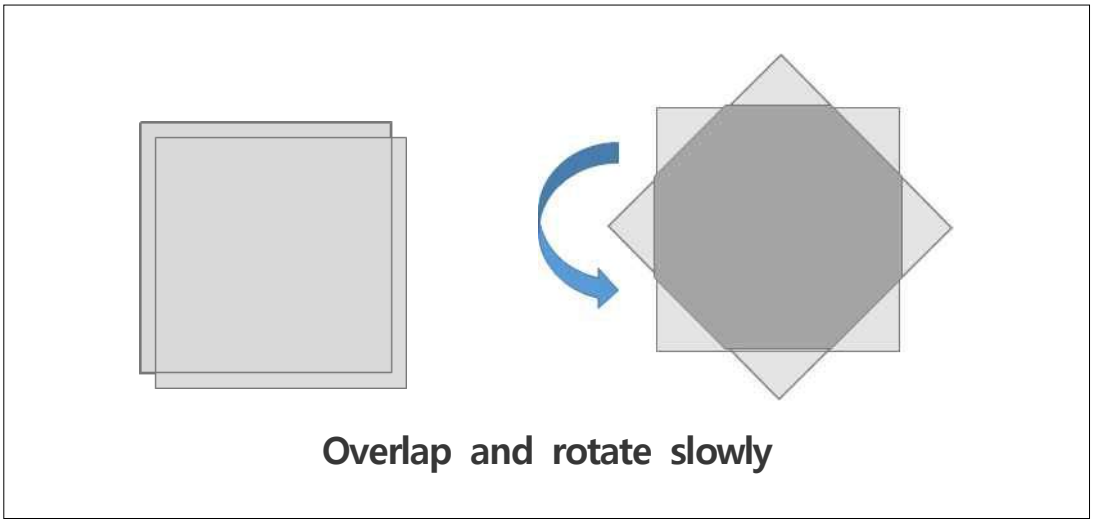
1. Observation

spep 1) After overlapping two polarized filters, rotate one of them to observe the visible phenomena.

※ Since the polarized filter has protective vinyl, the protective film on the

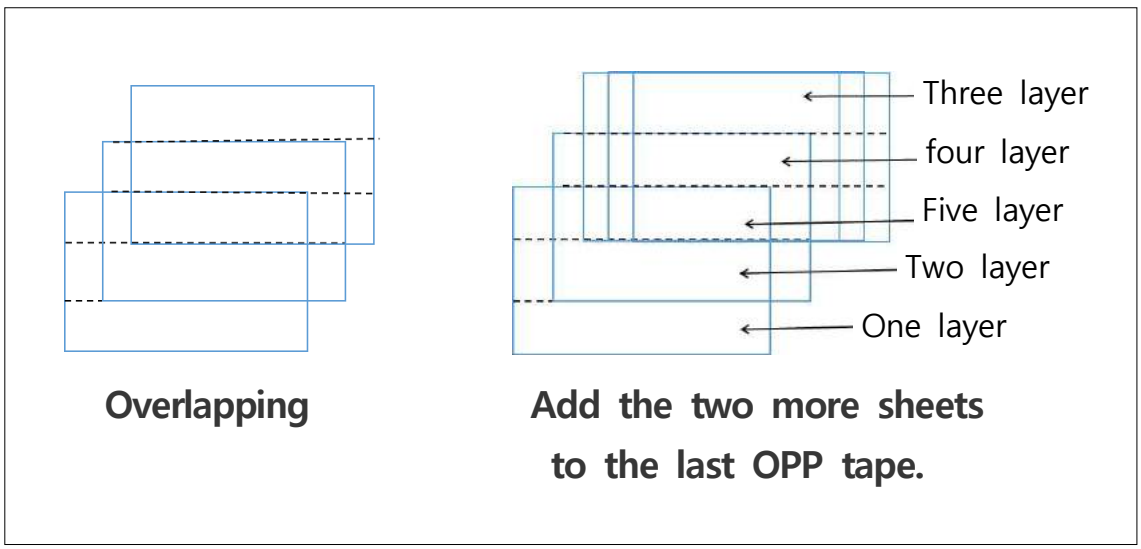
front and back must be removed and used.

※ Polarized filter may be attached to petri dishes to be used.



step 2) Add over 2/3 overlap of OPP tape on PVC film. Add three more in the same way. Add two more tapes to the last tape.

※ OPP tape can be replaced with OPP film.



spep 3) Put the one made in step 2) between the two polarized filters and observe it. Let's observe by rotating only one layer of polarized filter.

spep 4) Attach layers 2 to 5 OPP tapes to the PVC film in different directions and insert them between the two polarized filters for observation.

2. Result & Thinking

- What happens when two polarised filters are combined in step1) and then rotated?

initial, stage	rotation of 40 °	rotation of 90°	rotation of 135°	rotation of 180°	rotation of 270°	rotation of 360°

■ Let's write down what we observed in steps 3) and 4). What regularity could you find?

3. Application -Polarized stained glass

1) Attach the OPP tape to the PVC film in the number of times that overlap the other direction.
2) Check the color and pattern of PVC films made in Process 1) between the two polarized films.
3) Attach OPP tape until desired colors and patterns are made.
4) Once the desired colours and patterns are made, place the PVC film between the two polarized filters and drill holes at one end to connect with the ○ ring.

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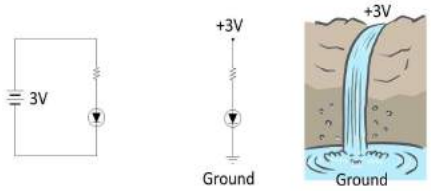
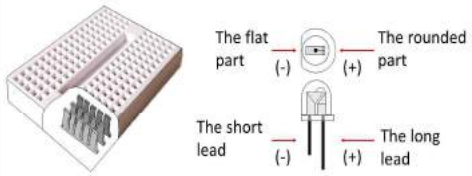
How transistors work

D.J. Lee / Majany J. M jorland@hanmail.net

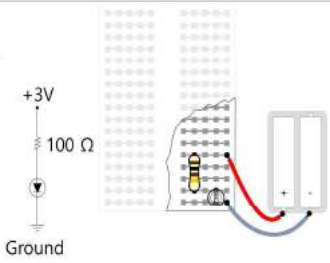
Notice 1. In this lecture, we will show electronic circuits in a long vertical line, like the water falls.



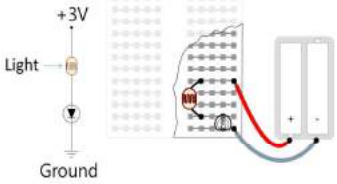
Notice 2. Let's observe the breadboard and LED.



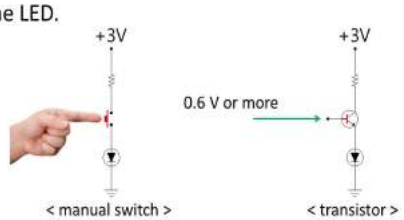
Activity 1.
light the LED.



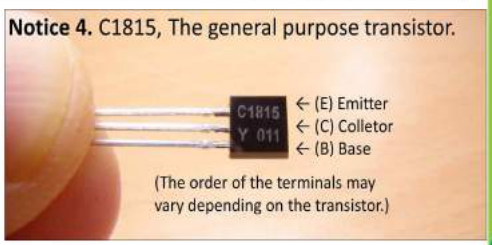
Activity 2.
CdS, the light sensor.



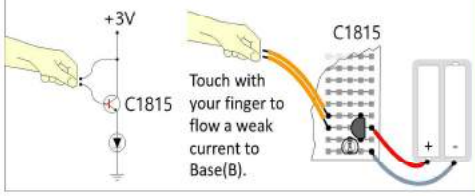
Notice 3. the transistor is used as a switch to turn on the LED.



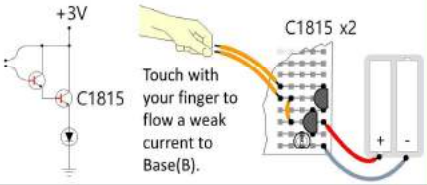
Notice 4. C1815, The general purpose transistor.



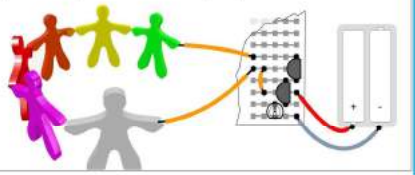
Activity 3. Touch sensor with transistor.



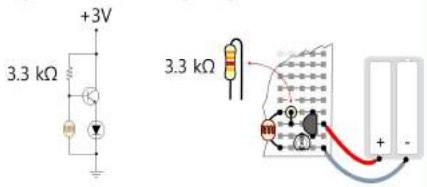
Activity 4. Touch sensor with transistor ×2.



Activity 4-2. Try with several people hand in hand.



Activity 5. Automatic night light.



Exercises.

1) What does the transistor do?
2) The transistor has three terminals. What are the names of the three terminals?
3) Which terminal of the transistor receives signal input from the outside?
4) Draw a path through the weak current on the "Activity 3" diagram. (From +3V to Ground) And draw a path through which a large current flows by turning on the LED. (From +3V to Ground)

08. How transistors work

Lee DongJoon

Ⅰ. Introduction and Background

Transistors are semiconductor components that are mainly used to amplify or switch electrical signals. The transistor can turn on or turn off the electrical signal and amplify the voltage and current.

The first electric computer was made in 1944. This computer contained logic circuits. In order to make a logic circuit, we need a switch that works by itself. The first computer used vacuum tubes as a switching element. However, the vacuum tube had a disadvantage in that the tube generated a lot of heat.

The transistors were first made by Walter Brattain, William Shockley and John Bardeen at Bell Labs in the United States in 1948. Transistors consume far less electrical energy than vacuum tubes. Besides, the response speed is faster than the vacuum tube. Since the development of transistors, industry has revolutionized. Smaller and cheaper radios, calculators, computers could be developed because of this transistor.

* Note: In this lesson we will look at how transistors actually work. Therefore, we are going to practice on electronic circuit with applied transistor. The structure of the transistor (npn, pnp) is not covered. If you want to study the structure of the transistor, please refer to separate materials.

Ⅱ. Learning Objectives

· To make a functioning transistor.
· To analyze the circuit in which the transistor is applied.

Ⅲ. Materials

· breadboard(170pin), jumper cable ×4, coin cell battery(CR2032), coin cell holder, LED(Red), resistance(100Ω, 3.3kΩ), CdS, transistor(C1815) ×2

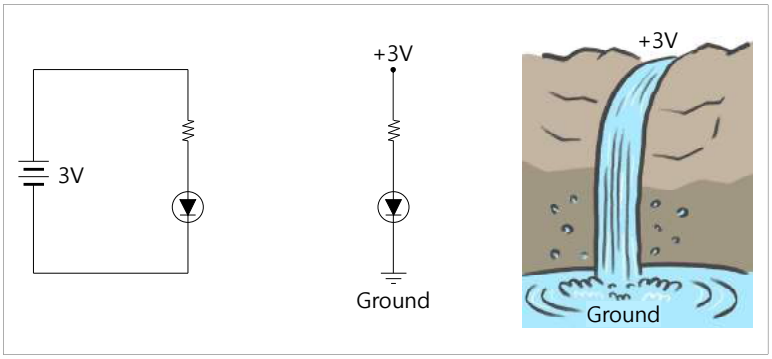
Ⅳ. Program Overview

Procedure	Activity Topics	Time required (minutes)
1	light the LED	15분
2	CdS, the light sensor	10분
3	touch sensor with transistor	25분
4	touch sensor with transistor ×2	20분
5	automatic night light	20분

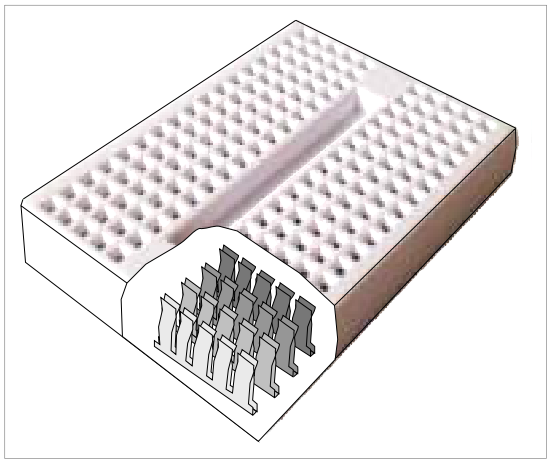
Ⅴ. Procedure

Activity 1 : light the LED

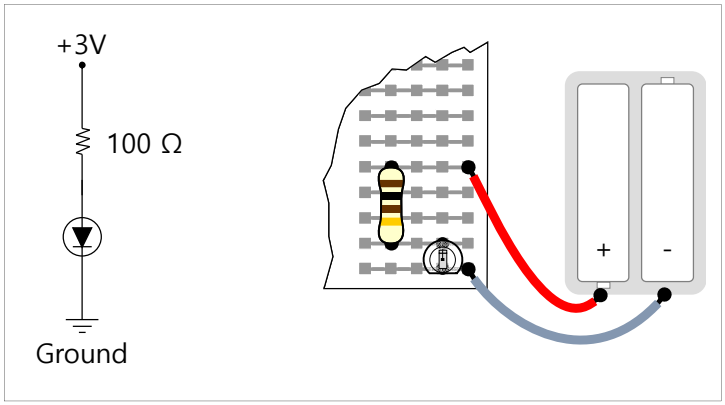
1) The electronic circuit consists of three components: 'power source', 'conducting wire', and 'load'. A 'power source' is a device that supplies electrical energy. ' The conducting wire' corresponds to the way current flows along the circuit. 'Load' is a device that actually works by using the supplied electrical energy. The electronic circuit turns around once and returns to its original position. However, in this lecture, we will show electronic circuits in a long vertical line, like the water falls.



2) Let's observe the breadboard. There are clips in the holes in the breadboard that hold parts. These pins make a electrical circuit by connecting the electric parts together.

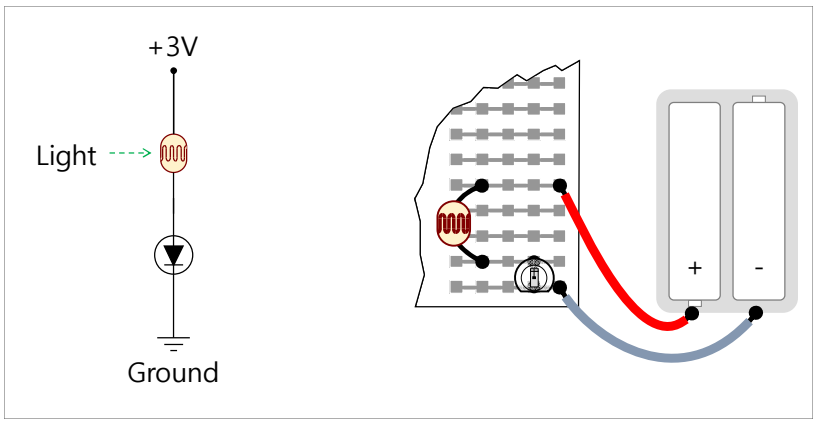


3) Let's observe the LED. LED is a part that emits light when the current flows. The LED has two legs. Make sure that the long legs point toward the positive side(+) of the battery and the short legs toward the negative side(-) of the battery.
4) Let's observe resistance. A resistor is a component that limits the flow of current. The resistance value is indicated by the color band on the side.
5) Turn on the LED by making the electric circuit as follows:



Activity 2 : CdS, the light sensor

1) CdS is a light sensor based on cadmium sulfide. When the ambient light is brighter, the resistance value of the sensor gets smaller.
2) Remove the resistor from the previous circuit and install the CdS sensor in place of the resistor.



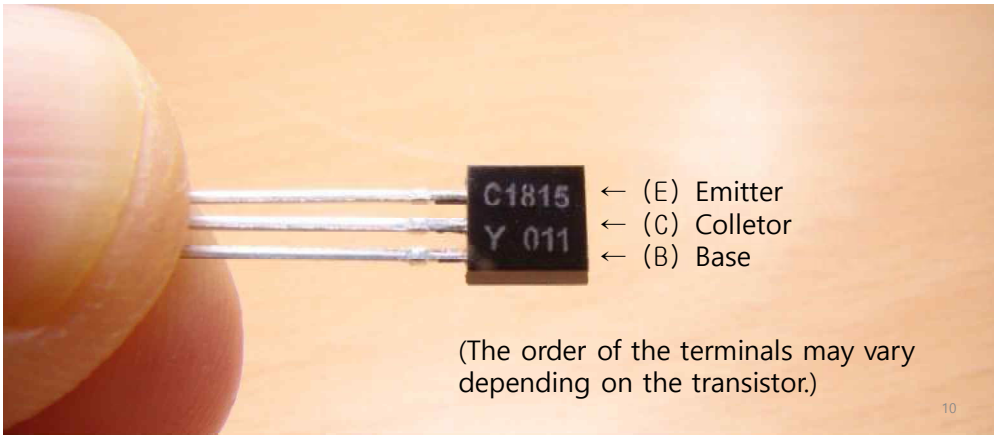
3) Observe the LED's brightness by adjusting the ambient light.

Activity 3 : touch sensor with transistor

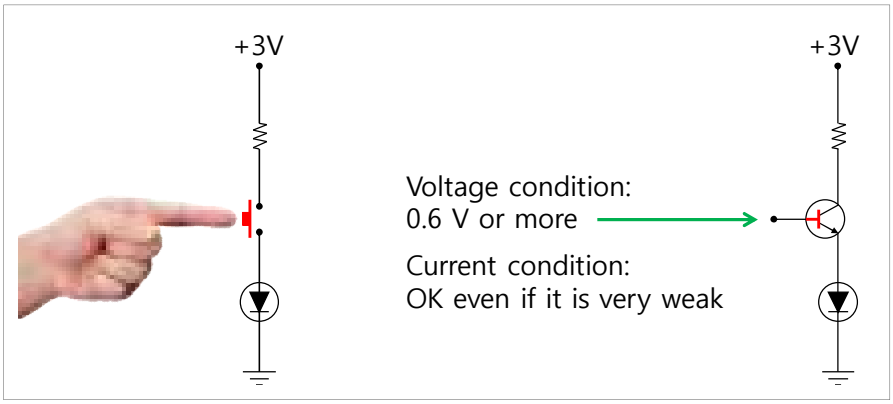
1) The transistor has three terminals. The names of the terminals are base(B), collector(C), and emitter(E).

Base(B) = signal input terminal
Collector(C) = terminal through which a large current flows
Emitter(E) = common terminal

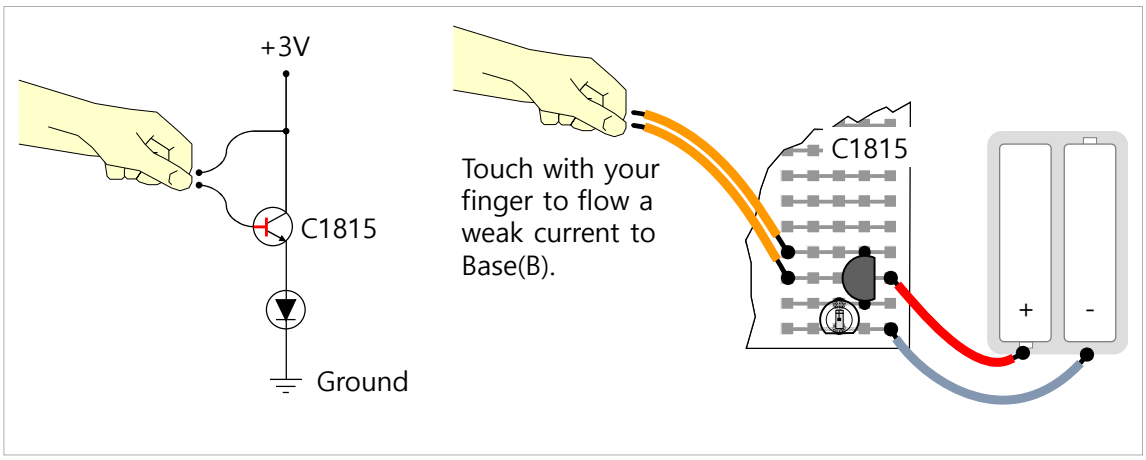
A typical transistor looks like the photo below. Many types of transistors are being produced worldwide today. Each transistor that is produced has different specifications. You can find the order of the terminals and other characteristics through an Internet search.



2) The basic circuit diagram of the transistor is shown below. In this circuit, the transistor is used as a switch to turn on the LED. Applying a weak voltage to the base(B) of the transistor will make the transistor the same as the closed switch. However, the base(B) voltage should be 0.6 ~ 0.7V or more.



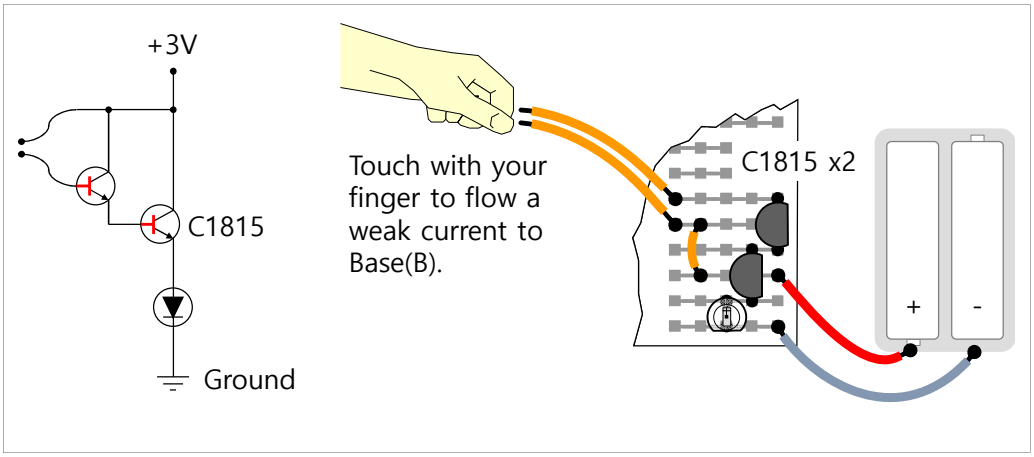
3) Make a circuit as follows. If you touch between the contact terminals with your fingers, a weak current flows into the base(B) of the transistor.



4) Describe the process of turning on the LED in the above circuit.

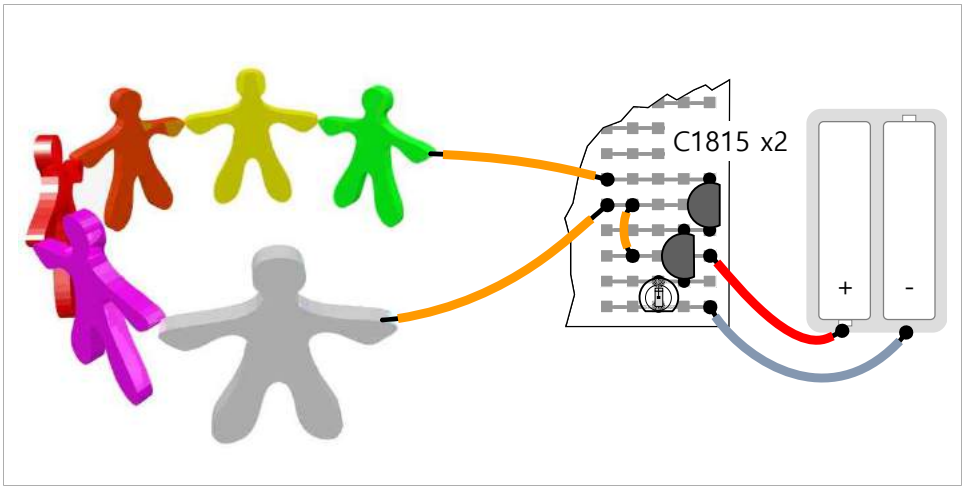
Activity 4 : touch sensor with transistor ×2

1) Add one more transistor to increase sensitivity.



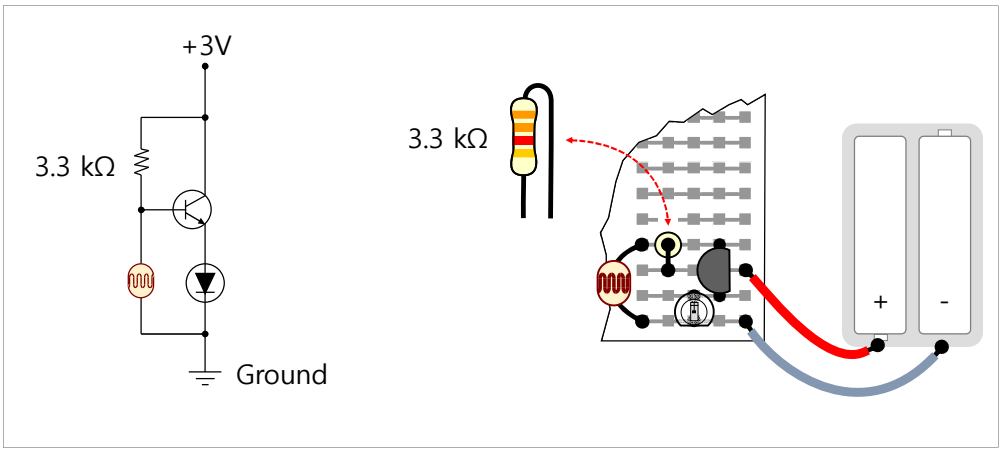
2) Describe how the circuit works.

3) Try with several people hand in hand.



Activity 5 : Automatic night light

1) Attach CdS to the ground and try to make it work against "activity 2".
A 3.3kΩ resistor is used together.



2) Describe how the circuit works.

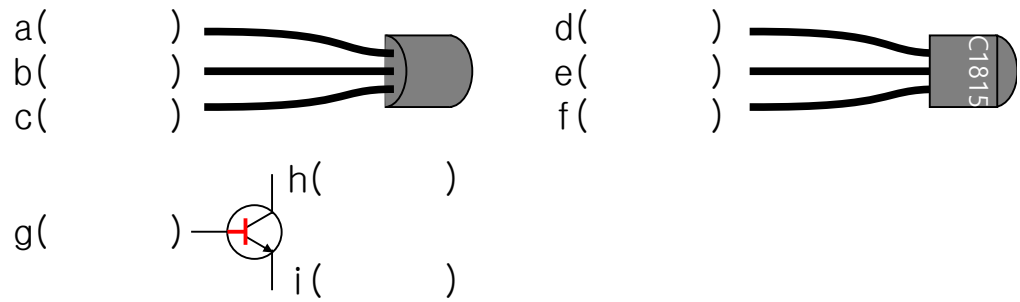
VI. Exercises

1) What does the transistor do?

1.

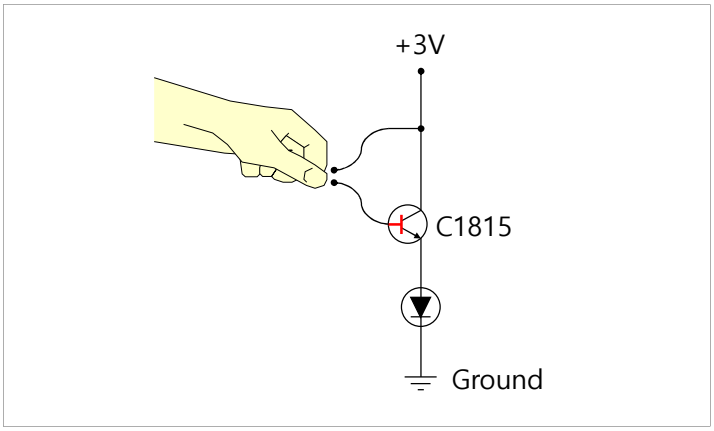
2.

2) The transistor has three terminals. What are the names of the three terminals?



3) Which terminal of the transistor receives signal input from the outside?

4) Draw a path through the weak current on the diagram below. (From +3V to Ground) And draw a path through which a large current flows by turning on the LED. (From +3V to Ground)



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Korea-Tanzania Mathematics & Science
2018 teachers PD workshop

Hands on Science Organization Tanzania (HSOT)

Electrolysis, Fun and Easy

I.H. SEO / Sala Samwel seoulteacher@hanmail.net

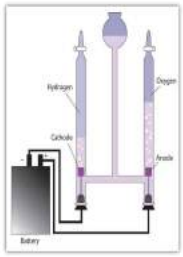
Class Overview

Activity	theme
1	Creating an electrolysis kit
2	Electrolysis of Water
3	Electrolysis of potassium Iodide Electrolysis of Copper Sulfate
4	Painting with Electrolysis

Activity 1 : Creating Electrolysis device

Electrode preparation | To connect the electrodes and wires | Complete the electro-lysis kit

1) Separate the electrodes (+) and the electrodes (-) from the devices you have created, and mark them with a oil based pen.
2) Compare your own electrolysis device to a typical electrolysis device.



Activity 2 : Electrolysis of water

Observation for Electrolysis of Water
① Immerse the electrodes in an aqueous solution and observe the change.
② Watch the change by dropping a drop of BTB solution onto each electrode.

List of observations	Observation	
	(+) electrode	(-) electrode
Air bubble generation		
color of a BTB solution		

Activity 3 : Electrolysis of aqueous solution

1) Observation for Electrolysis of a Potassium iodide Solution
2) Observation for Electrolysis of Copper Sulfate

KI solution

Electrodes	Observation	Explanation
(+)		
(-)		

$CuSO_4$ solution

Electrodes	Observation	Explanation
(+)		
(-)		

Activity 4 : Drawing using electrolysis

① Cut the filter paper to fit the bottom of the Petri dish and put it on the floor.
② Prepare a mixed solution by shaking a few drops of phenolphthalein solution in an aqueous solution of sodium chloride(NaCl).
③ Pour the mixed solution into the filter paper to allow enough water to soak into the filter paper, and then remove the solution on the filter paper.
④ Immerse one electrode in an aqueous solution and observe the changes in each electrode.
③ Fix the (+) electrode to the floor and connect the connection jack to the (-) electrode and draw a picture on the filter paper to the other end of the connecting jack.

Electrodes	Observation	Explanation
(+)		
(-)		

Discuss what other interesting games are available using electrolysis.

09. Electrolysis, Fun and Easy

SEO IN HO

Ⅰ. Introduction

The decomposition of the compound and the discovery of the element led to the start of modern chemistry. French chemist Ravoisier has obtained oxygen through thermal decomposition and proved it one of the basic elements of matter. Through these findings chemistry is at the start of its development into learning. British chemists Michael Faraday and Humphrey Davy used electrolysis as a revolutionary way to break down compounds and discover elements

Even in school classes, you can easily and simply create an electrolysis device to break down various substances. In electrolysis of an aqueous solution, different chemical reactions may occur depending on the type of electrolyte you put in the water. It can also be a fun activity to paint using an electrolysis device. This can increase your students interest in chemistry classes.

Ⅱ. Learning Objectives

· Make a simple electrolysis device.
· Decompose water using the electrolysis device and explain the principle.
· Decompose potassium Iodide solution and copper sulfate solution using the electrolysis device, and identify elements that are produced.
· Draw a picture using the electrolysis device.

Ⅲ. Preparation

(Tanzanian TOT teacher Preparation)

· Potassium Iodide, Copper Sulfate, soluble starch powder, Sodium Chloride, Phenolphthalein Solution, BTB Solution, Sodium Sulfate, Battery(9V, 6F22), Scissors, (Petri) Plate, Scissors, Stationery cutter, Matches

(Korean Teacher Preparation)

· Pencils, battery-in dogs, Sellotape, filter paper, transparent straw, incense, oil-based pens, wires with tongs

Ⅳ. Class Overview

Sequence	Activity theme	Time(min)
1	Creating an electrolysis kit	20
2	Electrolysis of Water	20
3	Electrolysis of potassium Iodide solution Electrolysis of Copper Sulfate Solution	30
4	Painting with Electrolysis	30

Ⅴ. Procedure

Activity 1 : Creating Electrolysis device

· **Objective** : You can create simple electrolysis devices and explain the principles of electrolysis.

· **Preparation** : 2 pencils, battery (9V, 6F22), battery drain dog, sellotape, stationery cutter

· activity process

1) **Electrode preparation** : prepare two pencils to cut the bottom layer of the pencil. It is also cut into a concave shape so that the pinhole of the upper part is visible.

2) **To connect the electrodes and wires** : Remove about 3 cm from the ends of the wires connected to the battery drain and wrap them in the pencil lead in the pencil lead in the upper part of the pencil electrode so that the wires and the pencil lead in a strong contact. Wrap the tape around it.

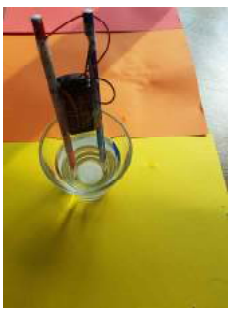
3) **Complete the electrolysis kit** : Insert a cell between two pencils and tape it so that the bottom half of the cell is about halfway through the pencil.



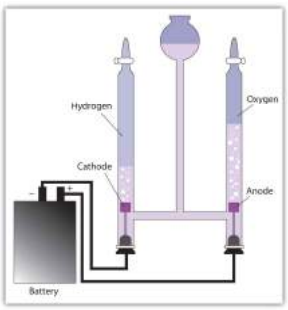
· **Results and theorem**

1) Separate the electrodes (+) and the electrodes (-) from the devices you have created, and mark them with a oil based pen.

2) Compare your own electrolysis device to a typical electrolysis device.



<Comparison>



Activity 2 : Electrolysis of Water

· **Objective** : The electrolysis device can break down water and explain its principles.

· **Preparation** : (Petri) dish, filter paper, BTB solution, sodium sulfate solution, matches, transparent straw, incense, and oil based pens.

· **activity process**

1) Preparation for Electrolysis of Water : Place 2/3 of the sodium sulfate solution in a Petri dish.

2) Observation for Electrolysis of Water

① Immerse the electrodes in an aqueous solution and observe the change.

② Watch the change by dropping a drop of BTB solution onto each electrode.

③ Create a way to collect the gases that occur on each electrode, and monitor their properties by collecting them.

· **Results and theorem**

1) Record your observations : Write down the air bubbles and the color changes caused by the BTB solution.

List of observations	Observation	
	(+) electrode	(-) electrode
Air bubble generation		
color of a BTB solution		

2) Try to determine the collection method and nature of the gas.

experiment procedure	Observation
How to collect gas	
The properties of a gas	(+)electrode: (-)electrode:

Activity 3 : Electrolysis of aqueous solution according to electrolyte

· **Objective** : Observe electrolysis in potassium iodide and copper sulfate solutions and explain the results of electrolysis in the type of electrolyte.

· **Preparation** : Electrolysis device, (Petri) dish, phenolphthalein solution, BTB solution, potassium iodide solution, copper sulfate solution, and soluble starch powder.

· **Activity process**

1) Observation for Electrolysis of a Potassium iodide Solution

① Put the potassium Iodide & starch solution in a Petri dish about two-thirds.

② Immerse the two electrodes of the electrolysis device in an aqueous solution and observe the changes that occur on each electrode.

③ Add a drop of phenolphthalein solution to the (-) electrode and observe the changes that occur.

2) Observation for Electrolysis of Copper Sulfate

① Place the copper sulfate solution in a Petri dish for 2/3.

② Immerse the electrodes of the electrolytic device in an aqueous solution and observe the changes in each electrode.

③ Observe the change that occurs after applying a drop of phenolphthalein solution to the (+) electrodes.

· **Results and theorem**

1) An Observation and Explanation of Electrolysis of Potassium iodide Solution

Electrodes	Observation	Explanation
(+)		
(-)		

2) An Observation and Explanation of Electrolysis of Copper Sulfate Solution

Electrodes	Observation	Explanation
(+)		
(-)		

Activity 4 : Drawing using electrolysis

· **Objective** : To motivate students to study chemistry in fun and easy ways by drawing pictures using an electrolytic reaction.

· **Preparation** : Electrolysis device, (petri) dish, filter paper, phenolphthalein solution, sodium chloride solution, wires with tongs, Scissors

· **Activity process**

① Cut the filter paper to fit the bottom of the Petri dish and put it on the floor.

② Prepare a mixed solution by shaking a few drops of phenolphthalein solution in an aqueous solution of sodium chloride.

③ Pour the mixed solution into the filter paper to allow enough water to soak into the filter paper, and then remove the solution on the filter paper.

④ Immerse one electrode in an aqueous solution and observe the changes in each electrode.

③ Fix the (+) electrode to the floor and connect the connection jack to the (-) electrode and draw a picture on the filter paper to the other end of the connecting jack.

· **Results and theorem**

1) An Observation and Explanation of Electrolysis of Sodium Chloride Solution

Electrodes	Observation	Explanation
(+)		
(-)		

2) Discuss what other interesting games are available using electrolysis.

▣ References and Web Site ▣

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2. electrolysis at home 2 ; https://www.youtube.com/watch?v=HQ9Fhd7P_HA

3. Payal Walia(2011). Fun with Science, Mind Melodies, DK.

Studying Acid Rain

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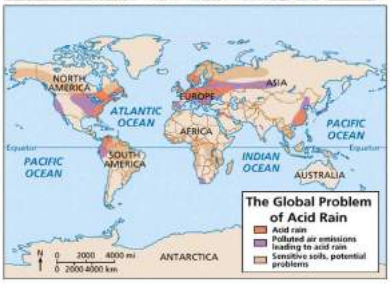
Purpose of Lesson

1. Learn causes and effects of Acid Rain
2. Discuss the effect of Acid Rain in our town and try to make solutions to protect.

Background



Activity : Influence of Acid Rain on Limestone, Metals and Plants

1. Make a table writing like this and place the 24-well plate.

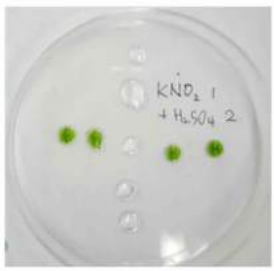
24-well plate	pH	A. Blank	B. Chalk	C. Shell	D. Metal1 ( )	E. Metal2 ( )	F. Plant ( )
HCl (or HNO_3)		○	○	○	○	○	○
Vinegar		○	○	○	○	○	○
Distilled water		○	○	○	○	○	○
Ammonia (or NaOH)		○	○	○	○	○	○

2. Put pieces of things(B~F) with different pH solutions.
3. Observe each hole and make reports.

Activity : What forms Acid Rains?

1. Effect of NOx (Materials : KNO_2, BCG, starch/KI, H_2SO_4, NH_3)
2. Effect of SOx (Materials : H_2SO_4, indicators, Na_2SO_3, NH_3)

* Drop the materials like below pictures and see the results.



Activity : Acid Rain on my Town / What can we do ?

1. Make a town with materials (mountain with rubber clay, factory with limestone, lake with distilled waters etc.)
2. Similarly with experiment (Effect of NOx), drop indicators and drop HNO_2 and H_2SO_4
3. Choose any topic related to acid rain and describe on paper ! (Efforts we'll do to reduce acid rain etc.)

10. Studying Acid Rain

Kim Minsun

Ⅰ. General Introduction

What causes the change of the statue and fish in the pictures?

Acid rain is rain or any other form of precipitation that is unusually acidic. It has harmful effects on plants, aquatic animals, and infrastructure. Acid rain is mostly caused by human emissions of sulfur and nitrogen compounds which react in the atmosphere to produce acids. In recent years, many government have introduced laws to reduce these emissions. How can we introduce 'Acid rain' in class?

Ⅱ. Learning Objectives

· We would explain the cause of Acid Rain and the influence of it on ecosystem.

· We would plan to introduce effect of Acid Rain and discuss solutions of it.

Ⅲ. Materials

Please check each activity section

Ⅳ. Safety Guide

· You must be careful not to touch chemicals on hands or skin.

· You must be aware of distance not to breathe emerging gas.

Ⅴ. Program Overview

Order	Activity Topic	Time (min)
1	Activity 1. Acid Rain word puzzle	10
2	Activity 2. Influence of Acid Rain on limestone/marble, metals and plants.	20
3	Activity 3. What forms Acid Rain?	20
4	Activity 4. Acid Rain on my town	25
5	Activity 5. What can we do?	25

VI. Procedure

Activity 1. Acid Rain word puzzle

Direction : All of the words that are listed below are hidden in the collections of scrambled letters. Your goal is to find as many words as possible. Look very carefully through the words. You can go forwards, backwards, up and down, and diagonally. How good are your detective skills?

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

Find Words

ACIDIC
CARS
COAL
ENERGY
FISH
FROGS
INSECTS
LAKE
RAIN
SNOW
SOIL
TREES
WALK
WIND

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

Find Words

ACIDIC
ACIDIFICATION
ALLOWANCE
BASIC
BUFFER
CARPOOL
CHEMICAL
COAL
DEPOSITION
ECOSYSTEM
EMISSIONS
GEOTHERMAL
HYDROPOWER
LEACHING
POLLUTION
SCRUBBERS

Activity 2. Influence of Acid Rain on limestone/marble, metals and plants

1. Materials

pH paper(or pH meter), 24 well plate, chalks, seashell (or eggshell), plates of metal(Mg, Zn, Cu), plant leaves or petals, distilled water, vinegar, hydrochloric acid (HCl) or nitric acid (HNO_3), ammonia(NH_3) or sodium hydroxide(NaOH)

2. Methods

1) Guess what will happen in each mixture of 24 well plate.
2) Pour distilled water, vinegar, acid, and base up to 1/3 into wells in each row.
3) Place nothing in Column A.
4) Repeat to test the pH of the each solution (Column A) and write results.
5) Place one piece of chalk in each well of Column B. Observe and write results.
6) Place small amount of seashell or eggshell in each well of Column C. Observe and write results.
7) Place plates of metal (Mg) in each well of Column D. Observe and write results.
8) Place plates of metal (Zn) in each well of Column E. Observe and write results.
9) Place parts of plant in each well of Column F. Observe and write results.

24-well plate	pH	A. Blank	B. Chalk	C. Shell	D. Metal1 ( )	E. Metal2 ( )	F. Plant ( )
HCl (or HNO_3)							
Vinegar							
Distilled water							
Ammonia (or NaOH)							

3. Result and Conclusion

1) What is the differences between each solution in pH?

2) Which piece of chalk is more worn away? and why?

3) What happens to the shells? and why?

4) What happens to metals? Are there any difference among the types of metals?

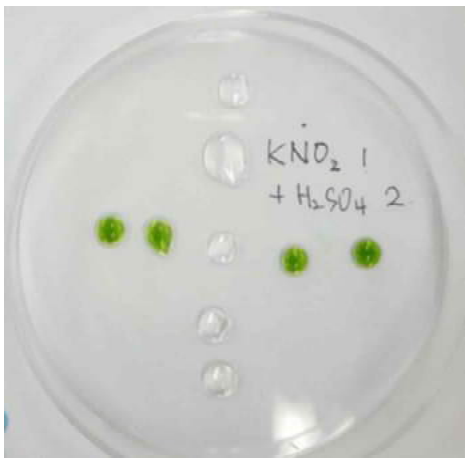
5) What happens to plants?

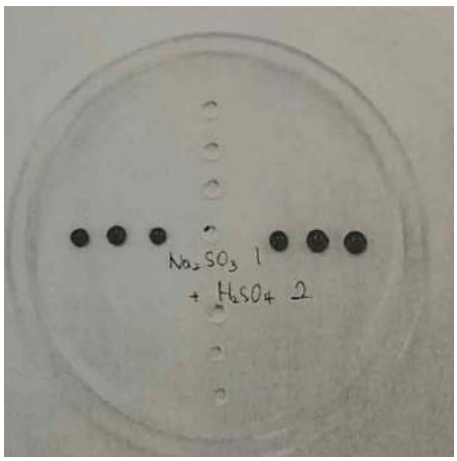
Activity 3. What forms Acid Rain?

1. Materials

Plastic petri dish with cover, Spoid pipet, distilled water, 3mL of solutions Bromocresol Green (BCG), Starch/KI solution, 0.5M KNO_2, 2M H_2SO_4, 0.2M H_2SO_4, 0.5M $Na_2S_2O_3$, 2M NH_3

2. Methods





[Effect of NOx]

1) Place 1 drop of 0.5M KNO_2 on the center of petri dish.
2) Place 3 drops of BCG indicator each on the left and right side of KNO_2. (BCG for test acidity)
3) Place 3 drop of starch/KI indicator each on the up and down side of KNO_2. (Starch/KI for test oxidizing power)
4) Cover half of the petri dish with its cover.
5) Drop 1 drop of 2M H_2SO_4 onto the center KNO_2 and rapidly cover the dish.
6) Observe and write results.

※ To stop the reaction, you need two drops of 2 drops of 2M NH_3 solution.

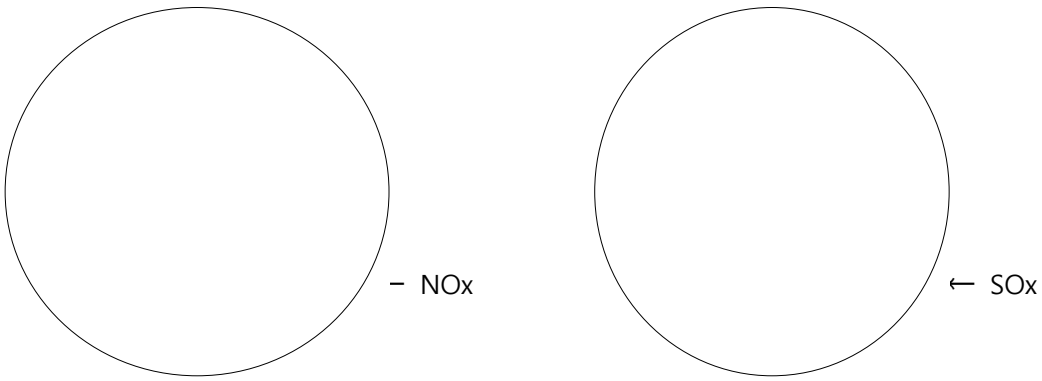
[Effect of SOx]

1) Place 2 drops of 0.2M H_2SO_4 on the center of petri dish.
2) Same with the [Effect of NOx], place some drops of BCG and starch/KI indicator.
3) Cover half of the petri dish with its cover.
4) Drop 1 drop of 0.5M Na_2SO_3 onto the center H_2SO_4 and rapidly cover the dish.
5) Observe and write results.

※ To stop the reaction, you need two drops of 2 drops of 2M NH_3 solution.

3. Result and Conclusion

1) Draw what you have observed. (Color of each drops)



2) **[Effects of NOx]** Complete the chemical equation.

$2\,KNO_2 + H_2SO_4 \rightarrow K_2SO_4 + H_2O + (\quad) + NO_2$

$2\,NO + (\quad) \rightarrow 2\,NO_2$

$3\,NO_2 + H_2O \rightarrow (\quad) + (\quad)$

3) Which gas causes acid rain?

Activity 4. Acid Rain on my town

1. Materials

Activity 2, Activity 3 materials, rubber clay, pins, small plants.

2. Methods

1) Make a town with materials (e.g. mountain with rubber clay, factory with limestone, lake with distilled water etc.)

2) Similarly with experiment **[Effects of NOx],** place some drops of indicators in front and back of mountain, lake, and other places of the town.

3) Place 1 drop of 0.5M KNO_2 on the center of petri dish, and cover half of it.

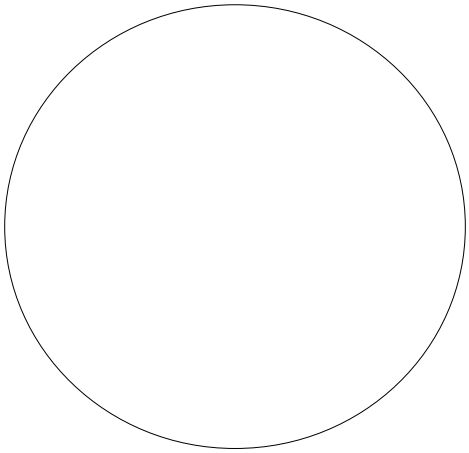
4) Drop 1 drop of 2M H_2SO_4 and rapidly cover the dish.

5) Observe and write results.

※ To stop the reaction, you need two drops of 2 drops of 2M NH_3 solution.

3. Result and Conclusion

1) Draw what you have created and observed with colors.



2) How can you explain the results?

Activity 5. What can we do?

1. Materials

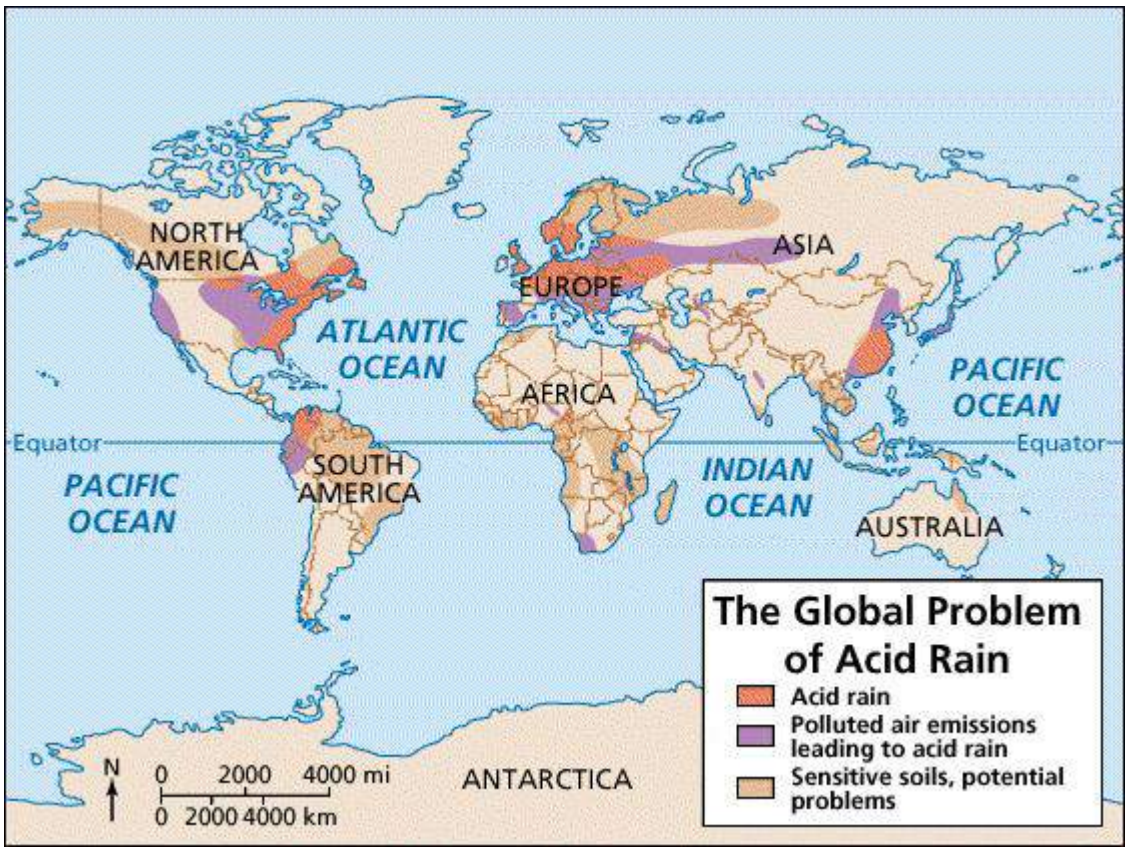
Paper, Color pencils, color pen

2. Methods

Choose any topic related to Acid Rain and describe on paper!

(e.g. Efforts we'll do to reduce acid rain, Message through acid rain session.)

Ⅶ. Background Knowledge



1. Causes of Acid Rain

Acid rain describes any form of precipitation with high levels of nitric and sulfuric acids. It can also occur in the form of snow, fog, and tiny bits of dry material that settle to Earth.

Rotting vegetation and erupting volcanoes release some chemicals that can cause acid rain, but most acid rain falls because of human activities. The biggest culprit is the burning of fossil fuels by coal-burning power plants, factories, and automobiles.

When humans burn fossil fuels, sulfur dioxide (SO2) and nitrogen oxides (NOx) are released into the atmosphere. These chemical gases react with water, oxygen, and other substances to form mild solutions of sulfuric and nitric acid. Winds may spread these acidic solutions across the atmosphere and over hundreds of miles. When acid rain reaches Earth, it flows across the surface in runoff water, enters water systems, and sinks into the soil.

2. Effects of Acid Rain

Acid rain has many ecological effects, but none is greater than its impact on lakes, streams, wetlands, and other aquatic environments. Acid rain makes waters acidic, and causes them to absorb the aluminum that makes its way from soil into lakes and streams. This combination makes waters toxic to crayfish, clams, fish, and other aquatic animals.

Some species can tolerate acidic waters better than others. However, in an interconnected ecosystem, what impacts some species eventually impacts many more throughout the food chain—including non-aquatic species such as birds.

Acid rain also damages forests, especially those at higher elevations. It robs the soil of essential nutrients and releases aluminum in the soil, which makes it hard for trees to take up water. Trees' leaves and needles are also harmed by acids.

The effects of acid rain, combined with other environmental stressors, leave trees and plants less able to withstand cold temperatures, insects, and disease. The pollutants may also inhibit trees' ability to reproduce. Some soils are better able to neutralize acids than others. In areas where the soil's "buffering capacity" is low, the harmful effects of acid rain are much greater.

3. What can be done?

The only way to fight acid rain is by curbing the release of the pollutants that cause it. This means burning fewer fossil fuels. Many governments have tried to curb emissions by cleaning up industry smokestacks and promoting alternative fuel sources. These efforts have met with mixed results. But even if acid rain could be stopped today, it would still take many years for its harmful effects to disappear.

Individuals can also help prevent acid rain by conserving energy. The less electricity people use in their homes, the fewer chemicals power plants will emit. Vehicles are also major fossil fuel users, so drivers can reduce emissions by using public transportation, carpooling, biking, or simply walking wherever possible.

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How does natural selection occur?

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Purpose of lesson

Using simulation, we can explain the principles of natural selection of birds with different types of beaks in various feeding environments.
we can explain the principles of natural selection of antibiotic-resistant bacteria.

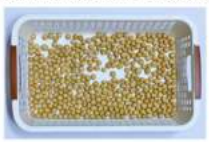
Preparation

· Teaspoons, two kinds of tongs, forceps, beans, sesame seeds, shallow baskets, tissues
· 100 pieces of round pompon(10mm), 100 white polystyrene styrofoam balls for modelling(10mm), shallow baskets, Velcro

Activity Procedure

Activity 1 : Simulation of natural selection by various feeding environments

1. Put the beans in a basket.




2. Four members of the team choose one of the following tools: teaspoon, two pieces of tongs, forceps.

3. Pick up the beans with each tool and put them on the tissue for 1 minute.
Count the number of beans on the tissue.
4. Repeat steps 1~4 three times with the tool of the person sitting on the left (everyone has to use four tools once).
5. Repeat steps 1~5 using sesame seeds instead of beans.

Activity 2 : Simulation of natural selection of antibiotic resistant bacteria by using antibiotics

1. Stick 20 pieces of round velcro on the bottom of disposable gloves.

2. A pompon will represent 'the bacterium that is not resistant to antibiotic' and a styrofoam ball will represent 'the antibiotic-resistant bacterium'.


3. Establish the rules for changing the number of bacteria by generation.
4. Four members constitute one team and share the role of the member of the team to determine the non-antibiotic-resistant bacteria regulator, the antibiotic-resistant bacteria regulator, the non-antibiotic-resistant bacteria counter, and the antibiotic-resistant bacteria count recorder.
5. The number of non-antibiotic-resistant bacterium and antibiotic-resistant bacterium is recorded for each generation by increasing or decreasing the number of bacteria in the basket from the 1st generation to the 5th generation according to the above rules, and the number of antibiotic resistant bacteria is calculated.

Result & Discussion

1. What is the most effective tool for picking beans and sesame seeds?
2. Is the most effective tool for picking beans and sesame seeds the same? If different, explain why.
3. If it is in nature, what would be the tools, the beans, and the sesame seeds? Let's also explain the experimental results with natural selection.

1. no. of bacteria by generation

generation	no. of non-antibiotic-resistant bacteria			no. of antibiotic-resistant bacteria			Percentage of antibiotic-resistant bacteria(%)
	death by antibiotic treatment	death by aging	survivor	death by antibiotic treatment	death by aging	survivor	
1							
2							
3							
4							
5							

2. Draw a graph of the percentage change in the generation of antibiotic-resistant bacteria.

11. How does natural selection occur?

Kyeongsoon Kim

Ⅰ. Introduction and Backgrounds

Evolution occurs when biological species change over many generations, rather than being static entities. Charles Darwin studied with interest the differences of beak size and shape between finches in the Galapagos Islands. Each organism has many variations in terms of shape, function, and habit. Among them, those individuals with the best genetic fitness for the environment will produce offspring that can compete more successfully in that environment. Thus the subsequent generation will have a higher representation of these offspring and the population will have evolved. Natural selection has taken place every time the environment has changed, and it is still happening. The purpose of this study is to understand the evolution of natural selection through simulation. The first activity is how birds with different types of beaks are selected according to different feeding environments. The second activity is designed to help students understand the natural selection of antibiotic-resistant bacteria by using antibiotics.

Ⅱ. Learning Objectives

· Using simulation, we can explain the principles of natural selection of birds with different types of beaks in various feeding environments.

· Using simulations, we can explain the principles of natural selection of antibiotic-resistant bacteria.

Ⅲ. Materials

· Teaspoons, two kinds of tongs, forceps, beans, sesame seeds, shallow baskets, tissues

· 100 pieces of round pompon(10mm), 100 white polystyrene styrofoam balls for modelling(10mm), shallow baskets, Velcro, A3 Sheets

Ⅳ. Program Overview

Order	Topics	Time(min.)
1	Simulation of natural selection by various feeding environments	50
2	Simulation of natural selection of antibiotic resistant bacteria by using antibiotics	50

Ⅴ. Procedures

Activity 1 : Simulation of natural selection by various feeding environments

- **Learning objective** : Using simulation, we can explain the principles of natural selection of birds with different types of beaks in various feeding environments.
- **Materials** : teaspoon, two kinds of tongs, forceps, beans, sesame seeds, shallow baskets, tissues
- **Activity Procedure**

1. Put the beans in a basket.


2. Four members of the team choose one of the following tools: teaspoon, two pieces of tongs, forceps.

3. Pick up the beans with each tool and put them on the tissue for 1 minute.
4. Count the number of beans on the tissue.
5. Repeat steps 1~4 three times with the tool of the person sitting on the left (everyone has to use four tools once).
5. Repeat steps 1~5 using sesame seeds instead of beans.

· Results and Discussion

1. Number of beans collected

	teaspoon	tong 1	tong 2	forceps
1st				
2nd				
3rd				
4th				
total				

2. Number of sesame seeds collected

	teaspoon	tong 1	tong 2	forceps
1st				
2nd				
3rd				
4th				
total				

3. What is the most effective tool for picking beans and sesame seeds?

beans :
sesame seeds :

4. Is the most effective tool for picking beans and sesame seeds the same? If different, explain why.

5. If it is in nature, what would be the tools, the beans, and the sesame seeds? Let's also explain the experimental results with natural selection.

Beans correspond to the natural environment essential for survival and reproduction, such as the food. On the other hand, picking tools correspond to the characteristics of living things that adapt to the natural environment, that is, individual variations. Thus, the effective tools for picking beans undergo natural selection that can be passed on to the next generation, which can then be used to pick up the beans again, and the proportion increases in later generations compared to the previous generations.

Activity 2 : Simulation of natural selection of antibiotic resistant bacteria by using antibiotics

- **Learning objective** : Using simulations, we can explain the principle of natural selection of antibiotic-resistant bacteria.

- **Materials** : 100 pieces of round pompon(15mm), 60 white polystyrene styrofoam balls for modelling(15mm), shallow baskets, Velcro, A3 Sheets

- **Before Activities**

1. Stick 20 pieces of round velcro on the bottom of disposable gloves.

Disposable glove with circular velcro

2. A pompon will represent 'the bacterium that is not resistant to antibiotic' and a styrofoam ball will represent 'the antibiotic-resistant bacterium'. If you do not have a styrofoam ball, you can put a tape on the pompon and use it as an antibiotic resistant bacteria model. (Pompon is attached to the velcro, but the polystyrene styrofoam ball is not attached to the velcro, so it is suitable for the natural selection process to take place.)

pompons

styrofoam balls

Q1. What does 'bacteria in the basket' mean?

It is a group of bacteria belongings to one environment.

Q2. What does it mean to "close your eyes and hold them with your hands to remove the bacteria at random"?

Some of the bacteria group that has not been treated with antibiotics will die without natural selection.

Q3. What does it mean to remove bacteria on the velcro?

'velcro' means 'antibiotics', and 'removing bacteria on velcro' means selective death of non-resistant bacteria, which are detrimental to survival in the environment treated with antibiotics.

3. Establish the rules for changing the number of bacteria by generation. The rules for changing the number of bacteria per generation can be instructed to simulate according to the following examples, but in the case of more able students' classes, students can set the rules for changing the number of bacteria through a discussion process or modify the illustrated rules.

< Example of changing the number of bacteria per generation >	
① The first generation of bacteria is formed by placing 16 non-resistant bacteria (pompon) and 4 individual resistant bacteria (styrofoam ball) in a basket.	
② If the total number of bacteria in the basket is less than 30, each individual will divide by dichotomy, and the number of bacteria will double to become the next generation. The daughter bacterium produced by cleavage is the same as that of the bacterium.	
③ In the environment treated with antibiotics, when the bacteria in the basket are pressed once with the gloves attached to Velcro, remove the bacteria attached to the Velcro and remove it (once).	
④ If the total number of bacteria is 30 or more, close your eyes, put your hands in the basket, mix the germs once, then take out handful of bacteria in a random way. This process is repeated until the number of individuals is less than 30.	
⑤ Repeat the above ② ~ ④ until 5 generations.	

· Activities

1. Four members constitute one team and share the role of the member of the team to determine the non-antibiotic-resistant bacteria regulator, the antibiotic-resistant bacteria regulator, the non-antibiotic-resistant bacteria counter, and the antibiotic-resistant bacteria count recorder.

2. The number of non-antibiotic-resistant bacterium and antibiotic-resistant bacterium is recorded for each generation by increasing or decreasing the number of bacteria in the basket from the 1st generation to the 5th generation according to the above rules, and the number of antibiotic resistant bacteria is calculated.

· **Results and Discussion**

1. no. of bacteria by generation

gener-ation	no. of non-antibiotic-resistant bacteria			no. of antibiotic-resistant bacteria			Percentage of antibiotic-resistant bacteria(%)
	death by antibiotic treatment	death by aging	survivor	death by antibiotic treatment	death by aging	survivor	
1							
2							
3							
4							
5							

2. Based on the records, draw a graph of the percentage change in the generation of antibiotic-resistant bacteria.

3. Discuss the impact of antibiotic use on the evolution of bacterial populations.

In the environment without antibiotics, the number of antibiotic-resistant bacteria is kept low because there is no special benefit. However, the use of antibiotics causes the bacteria that are not resistant to antibiotics to die, and the antibiotic-resistant bacteria will survive and reproduce. Therefore, as time passes, the number of the antibiotic-resistant bacteria increases and then most of the population consists of antibiotic resistant bacteria. That is, the more the antibiotics are used, the more antibiotic-resistant bacteria are selected and the ratio of the bacteria increases sharply.

4. Let's talk about what we can do to prevent the increase of antibiotic resistant bacteria.

Antibiotics are prescribed only when absolutely necessary.
When using antibiotics, prescribe exactly the dosage and good adherence to the prescription.
Reduce antibiotics administered to livestock.

5. (Further study) Considering the acquisition of antibiotic resistance by horizontal gene transfer, what steps should be added to the experiment?

Bacteria are able to transfer genes between individuals. Therefore, non-antibiotic-resistant bacteria in the vicinity of antibiotic-resistant bacteria gets converted to antibiotic-resistant bacteria.

Korea-Tanzania Mathematics & Science
2018 teachers PD workshop

Hands on Science Organization Tanzania (HSOT)

Learning cell division using model

M.J. Kim / Happiness Justian parakim3@gmail.com

Purpose of Lesson

- We can make a chromosome model, and We can use the model to explain the structure of chromosome and the process of change.
- Using the chromosome model, somatic cell division and germ cell division process can be expressed.
- Using the chromosomal model, we can explain genetic processes that occur through the division and fertilization of germ cells.

Class Overview

Order	Topics
1	Making a chromosome model
2	Describing the process of cell division using the chromosome model
3	Describing the genetic process using the chromosome model

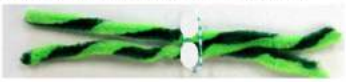
Materials

- Pipe cleaner, clay, ballpoint pen, scissors, worksheets

Activity Procedures

Activity 1 : Making a chromosome model

1) Making G1 phase chromatin : Prepare one each of the same series of color Pipe cleaners and twist them.



2) Making S phase-pasted chromatin: Prepare two sets of the same type of Pipe cleaners, twist each to make two sets, attach the clay to the appropriate position and attach them to each other.

3) Making chromosomes of cell division Prophase : Prepare two sets of the same series of color Pipe cleaners, twist each to make two sets, attach the clay to the proper location, attach them to each other, and then twist using a ballpoint pen to make a condensed shape.

4) Place the made chromosome model, place the NameTag in the proper position, and explain what each part of the model represents.

NameTag contents: Chromosome, mobilization, sister chromatid, chromatin

Activity 2 : Describing the process of cell division using the chromosome model

① Cut two sheets of white paper into a circle.
② Put four chromatin before condensation on white paper, and put two black clay corresponding to central body around white paper.
③ Express the chromatin with DNA replication and attach the white clay corresponding to the mobilization to the proper position. At this time, the position of the black clay is moved to the opposite side.
④ Use a ballpoint pen to condense dye, express electricity as the beginning of Mitosis, and attach a thread to the central body to express the spindle stretching out.
⑤ expressing the disappearance of the nuclear membrane by removing white paper, and expressing the changes from the metaphase to anaphase of somatic cell division using chromosome and spindle.
⑥ Expression of the change of somatic cell division at the telephase showing 2 white paper.

To create a stop-motion animation, download the following stop-motion production application and shoot each scene to make it au tomatically.

Activity 3 : Describing the genetic process by modeling

① Express the change of chromatin occurring during the interphase of the cell cycle by placing four chromatin before condensation on white paper. At this time, two chromosomes can express sex chromosomes, and two pairs are prepared. (Holster orthography uses XY type.)
② wrap the color tape on the pipe cleaner and express the gene using the alphabet. At this time, color tape is attached so that the genes of the anchovy corresponding to homologous chromosome are different from each other.

③ Two pairs are each subjected to Meiosis process to make four reproductive cells, respectively.
④ Select the germ cells randomly to be mutually modified using a method such as lot drawing.
⑤ Place the germ cells determined to be mutually modified on one white paper and check the combination of genes.

12. Learning cell division using model

Kim Mijung

Ⅰ. Introduction and Backgrounds

Life forms new cells through cell division to increase the size of an individual, or to restore damaged parts. It also becomes a new entity through cell division. In this process, newly created cells receive information from the mother cells, which are carried on chromosomes. The chromosomal changes that occur in the process of cell division are difficult to observe directly by the eye, and therefore, we have to understand the process in an abstract way. In order to understand more easily, we can make a chromosome model and understand the movement of chromosomes in the process of cell division and the process of changing genetic information in chromosomes more easily by using the model.

Ⅱ. Learning Objectives

· We can make a chromosome model, and We can use the model to explain the structure of chromosome and the process of change.
· Using the chromosome model, somatic cell division and germ cell division process can be expressed.
· Using the chromosomal model, we can explain genetic processes that occur through the division and fertilization of germ cells.

Ⅲ. Materials

· Pipe cleaner, clay, ballpoint pen, scissors, worksheets

Ⅳ. Program Overview

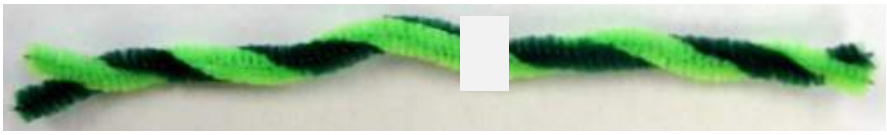
Order	Topics	Time(min.)
1	Making a chromosome model	40
2	Describing the process of cell division using the chromosome model	30
3	Describing the genetic process using the chromosome model	30

Ⅴ. Procedures

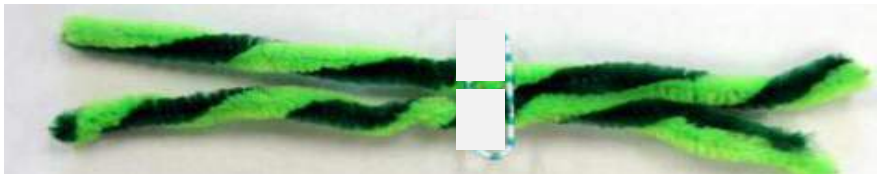
Activity 1 : Making a chromosome model

· Objective : We can make a chromosome model and explain the structure and change process of chromosome using model.
· Materials : 16 Pipe cleaners, ball point pens, clay, scissors, NameTag, Worksheet
· procedure

1) Making G1 phase chromatin : Prepare one each of the same series of color Pipe cleaners and twist them.



2) Making S phase-pasted chromatin: Prepare two sets of the same type of Pipe cleaners, twist each to make two sets, attach the clay to the appropriate position and attach them to each other.



3) Making chromosomes of cell division Prophase : Prepare two sets of the same series of color Pipe cleaners, twist each to make two sets, attach the clay to the proper location, attach them to each other, and then twist using a ballpoint pen to make a condensed shape.

4) Place the made chromosome model, place the NameTag in the proper position, and explain what each part of the model represents.

NameTag contents: Chromosome, mobilization, sister chromatid, chromatin

· Results

1) What does an Pipe cleaner before winding and Pipe cleaner after winding use a ballpoint pen?

- Pipe cleaner before winding means Chromatin, and Pipe cleaner after winding means condensed chromosome.

2) What do the X-shaped Pipe cleaner mean and what are their characteristics?

- Sister chromatid, and the genetic information is the same.

3) What does clay mean?

- The position of the centromere the location of the element.

4) What are the characteristics of the two DNAs produced as a result of DNA replication?

- One strand of DNA that is complementary to each other is conserved, resulting in a DNA with the same information.

Activity 2 : Describing the process of cell division using the chromosome model(Creating a stop motion animation)

· Objective: Using the chromosome model, the process of cell division can be expressed, and the image of change process can be photographed.

· Materials: chromosome model, clay, thread, pen, white paper, scissors, Work sheet,

(smartphone)

· Activities

1) express Mitosis

① Cut two sheets of white paper into a circle.

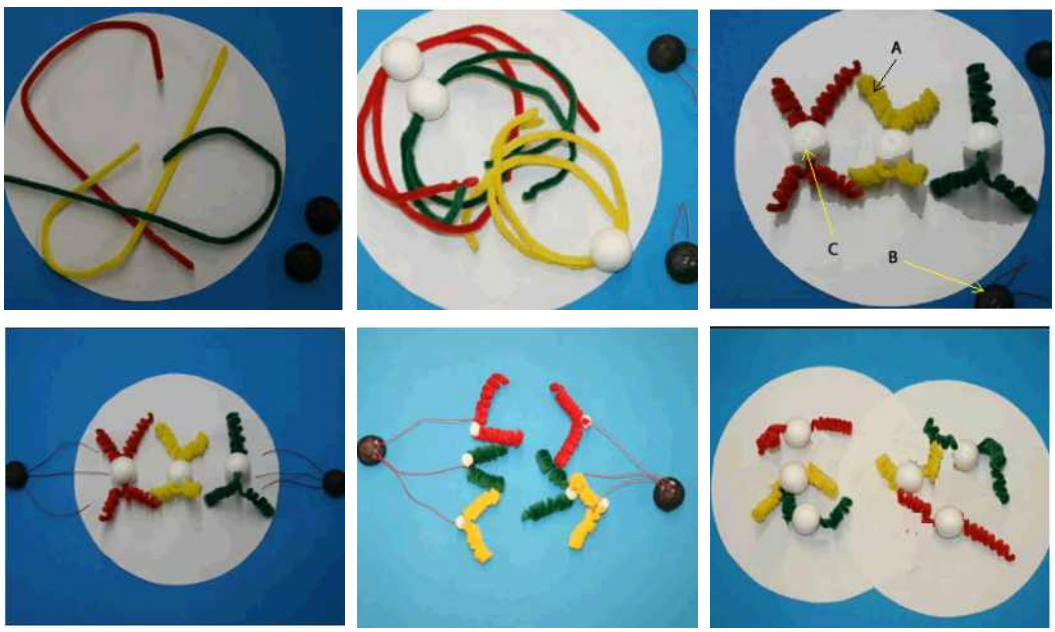
② Put four chromatin before condensation on white paper, and put two black clay corresponding to central body around white paper.

③ Express the chromatin with DNA replication and attach the white clay corresponding to the mobilization to the proper position. At this time, the position of the black clay is moved to the opposite side.

④ Use a ballpoint pen to condense dye, express electricity as the beginning of Mitosis, and attach a thread to the central body to express the spindle stretching out.

⑤ expressing the disappearance of the nuclear membrane by removing white paper, and expressing the changes from the metaphase to anaphase of somatic cell division using chromosome and spindle.

⑥ Expression of the change of somatic cell division at the telephase showing 2 white paper.



To create a stop-motion animation, download the following stop-motion production application and shoot each scene to make it automatically.

2) Expression of Meiosis

① Express the change of chromatin occurring during the interphase of the cell cycle by placing four chromatins before condensation on white paper. At this time, two chromosomes can express sex chromosomes.
② Using a ballpoint pen to condense the dyes to express the beginning of cell division, dysplastic chromosomes to express the Meiosis prophase 1.
③ Remove the white paper, express the changes of the spindle and the chromosomes, and express the change from the metaphase to the anaphase of Meiosis 1.
④ Put two white paper and express the change that occurs at the telephase of Meiosis 1.
⑤ reproductive cells express the prophase 2.
⑥ Remove the white paper, express the changes of the spindle and the chromosomes, and express the change from the metaphase to the anaphase of Meiosis 2.
④ Put 4 white paper and express the change that occurs at the telephase of Meiosis 2.

· Results

1) Let's summarize the table showing Mitosis and Meiosis process and results.

Characteristic	체세포 분열	생식세포 분열
Number of chromosomes per cell before initiation	4	4
Number of chromosomes per cell after cell division	4	2
Number of DNA strands per cell before initiation	4	4
Number of DNA strands per G2 cell	8	8
DNA strands per cell after cell division	4	2
Number of daughter cells made from one cell	2	4
Number of divisions	1	2
Pair of homologous chromosomes before cell division	2	2
After homologous chromosomal pairing	2	-

2) When does Mitosis begin to differ from Meiosis? What are the other characteristics?

- In Prophase of Meiosis, Homologous chromosomes are paired to form a Synapsis, and homologous chromosomes move to different cells.

Activityy 3 : Describing the genetic process by modeling (creating stop motion animation)

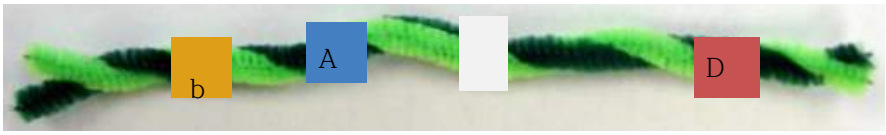
· Objective: Using the chromosomal model, we can express the process of gene transfer from the parent to the offspring through fertilization.

· Materials : chromosome model, clay, thread, paper tape, ballpoint pen, white paper, scissors, Worksheet, (smartphone)

· Procedure

① Express the change of chromatin occurring during the interphase of the cell cycle by placing four chromatin before condensation on white paper. At this time, two chromosomes can express sex chromosomes, and two pairs are prepared. (Holster orthography uses XY type.)

② wrap the color tape on the pipe cleaner and express the gene using the alphabet. At this time, color tape is attached so that the genes of the anchovy corresponding to homologous chromosome are different from each other.



③ Two pairs are each subjected to Meiosis process to make four reproductive cells, respectively.

④ Select the germ cells randomly to be mutually modified using a method such as lot drawing.

⑤ Place the germ cells determined to be mutually modified on one white paper and check the combination of genes.

· Results and organization

1) Gross cell division result Let's summarize the combination of genes.

	Female	**Male**
Pre-division genetic organization		
Genetic organization of each cell after division		

2) Let's write about the genetic composition of the offspring made after the modification.

Sex	Composition of Genes

3) Compare the results of the other groups and look for the percentage of the same genetic composition.

4) What is the meaning of the proportion of descendants with the same genetic composition, and what is the significance of sexual reproduction that can be found through this?

▣ References ▣

https://www.biologycorner.com/worksheets/pipeprep.html

http://dqc.crcstl.msu.edu/cell/keeping-track-mitosis

http://www.dynamicscience.com.au/tester/solutions1/biology/inheritance/mitosiactivity.html

Korea-Tanzania Mathematics & Science
2018 teachers PD workshop

Hands on Science Organization Tanzania
(HSOT)

DNA extraction and making a DNA model

Yoonhee Choi, Smawel Muharagi, Daudi yunissam524@naver.com

Activity 1 : Extracting DNA from cells

◎ Activity Procedure

Step 1)	Step 2)	Step 3)-1
Put banana in plastic bag and crush finely until lump disappears. 	Add detergent and salt into the cup(50ml) and fill it with water. Mix the crushed banana with the solution and leave it for 3 minutes. 	Make a banana cell DNA extract by running the solution through a piece of gauze to remove the residue of banana. 
Step 3)-2	**Step 4)**	**Step 5)**
And put about 1/3 of the extract in the glass bottle. 	Pour 2 times cold ethanol than the banana cell DNA extract with pipette along the wall of the glass bottle. 	Observe whether there is a thin thread-like substance on the surface of the banana DNA extract. 

◎ Result and Conclusion

1) Why do you put powdered soap and salt in this experiment?
2) Why do you put ethanol in this experiment?
3) What is the color and shape of the substance that comes from adding ethanol to the banana extract?
4) How can we check whether extracted thin thread-like substance is DNA?

Activity 2 : Extracting DNA from cells

◎ Activity Procedure

Step 1)	Step 2)	Step 3)
Cut straws of four colors into small pieces of 4cm. (11 pieces per color) 	Tape two straws of different colors with cello tape. ex) Red - blue, yellow- green 	put the straw pieces connected in step 2) with 2 cm intervals between them. 
Step 4)	**Step 5)**	**Step 6)**
Attach a black tape to the other side as shown. 	Attach the wooden chopsticks on both ends to woodlock plate. 	Fix the lower plate and turn the upper plate 360° counterclockwise, then fix it as shown. 

◎ Result and Conclusion

1) What does the four-colored straw piece represent?
2) What does black tape represent?
3) What shape does the DNA model look like and in which direction is it twisted ?
4) With reference to the DNA model, how many nucleotide pairs did the DNA double helix contain per rotation?

13. DNA extraction and making a DNA model

Choi Yoon Hee

Ⅰ. Introduction and Background

Most cells that make up an organism have a nucleus, and a nucleus contains DNA that has genetic information. By analyzing DNA that is extracted from a cell, it can be used for diagnosis of genetic diseases, investigation of crime, and searching for lost children. Let's extract DNA form the cells of various plants that lives around us.

Also, the double helix structure of DNA was also revealed by Watson and Crick. Watson and Crick created their own DNA models using wires, steel plates, and screws to clarify their ideas about DNA structure. Let's understand the structure of DNA through the activity of making a model of DNA with our own hands.

Ⅱ. Learning Objectives

· Can observe real DNA extracted from banana cells.

· Can understand the structure of DNA by making DNA model.

Ⅲ. Materials

· Banana, detergent(surfactant), salt, water, ethanol, glass bottle with pipette, plastic bag, cup, gauze, straw (four colors), cello tape, black tape, scissors, wooden chopsticks

Ⅳ. Program Overview

순서	활동주제	소요 시간(분)
1	Extracting DNA from cells	50minutes
2	Making a DNA model	50minutes

Ⅴ. Procedure

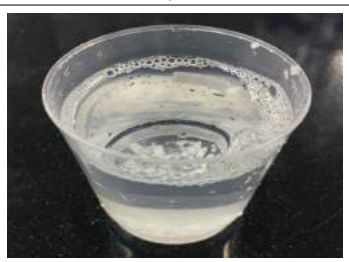
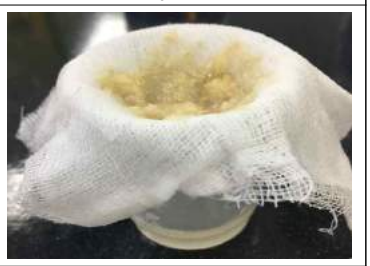
Activity 1 : Extracting DNA from cells

· objective : Can observe real DNA be extracted from banana cells.

· Materials : Banana, detergent(surfactant), salt, water, ethanol, glass bottle with pipette, plastic bag, cup, gauze, straw.

· Activity step

1) Put banana in plastic bag and crush finely until lump disappears.
2) Add 3 tablespoons of detergent and 2 tablespoons salt into the cup(50ml) and fill it with water. Mix the crushed banana with the solution and leave it for 3minutes.
3) Make a banana cell DNA extract by running the solution through a piece of gauze to remove the residue of banana. And put about 1/3 of the extract in the glass bottle.
4) Pour 2 times cold ethanol than the banana cell DNA extract with pipette along the wall of the glass bottle.
5) Observe whether there is a thin thread-like substance on the surface of the banana DNA extract.

Step 1)	Step 2)	Step 3)-1
		
Step 3)-2	Step 4)	Step 5)
		

· Result and Conclusion

1) Why do you put powdered soap and salt in this experiment?

2) Why do you put ethanol in this experiment?

3) What is the color and shape of the substance that comes from adding ethanol to the banana extract?

4) How can we check whether extracted thin thread-like substance is DNA?

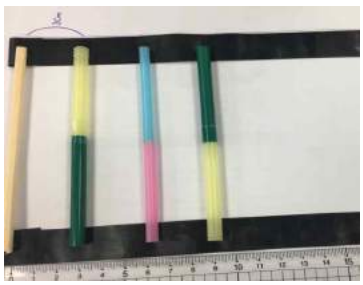
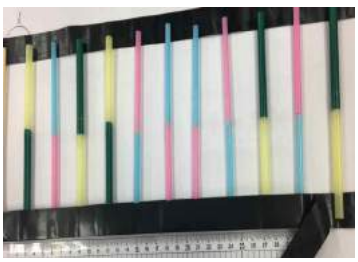
Activity 2 : Extracting DNA from cells

· objective : Can understand the structure of DNA by making DNA model.

· Materials : Straw (four colors), cello tape, black tape, scissors, wooden chopsticks

· Activity step

1) Cut straws of four colors into small pieces of 4cm. (11 pieces per color)
2) Tape two straws of different colors with cello tape. ex) Red - blue, yellow- green
3) Place wooden chopsticks at the front and the end of the black tape, and put the straw pieces connected in step 2) with 2 cm intervals between them.
4) Attach a black tape to the other side as shown.
5) Attach the wooden chopsticks on both ends to woodlock plate.
6) Fix the lower plate and turn the upper plate 360 ° counterclockwise, then fix it with wooden chopsticks as shown.

Step 1)	Step 2)	Step 3)
		
Step 4)	Step 5)	Step 6)
		

· Result and Conclusion

1) What does the four-colored straw piece represent?

2) What does black tape represent?

3) What shape does the DNA model look like and in which direction is it twisted ?

4) With reference to the DNA model, how many nucleotide pairs did the DNA double helix contain per rotation?

5) Place the bases that is in your DNA model in the right order under the following condition.

<Condition>
( ) : adenine (A), ( ) : guanine (G), ( ) : cytosine (C), ( ) : thymine (T)

① Left DNA strand :

② Right DNA strand :

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Hands on Science Organization Tanzania
(HSOT)

Causes that affect the size of the population

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Summary of lesson

1. Using gaming with dices, we can observe changes in elephant population in Mpya game reserve(imaginary space) and graph changes of population size.
2. We analyze the graph and find causes that affect the size of the population.
3. We will seek alternative measures for sustainable reserve area.

Activity Procedure

Activity 1 : Playing a game with dices and record the number of dices.

1. Put 13 dices in a basket.

2. Throw 13 dices in the basket to keep 13 dices in the basket. (1 throwing=3 years)

3. Add or remove dices as the rules.

4. Record the changes of number of dices.

Years	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
Size of population	13																				
Birth (1 or 2)																					
Death: Aging (3)																					
Death: Disease (4)																					
Death: Famine (5)																					
Death: Poaching(6)																					

5. Throw all dices in the basket to keep all dices in the basket.

6. Repeat steps 3~5 until there are no dices in the basket or you throw 20 times.

7. Graph the record and compare the predicted graph

8. Think and discuss about the causes that affect the size of the elephant population.

The Rule for Game

(1) Adding(=Birth of Elephant)

i) add 1 dices

ii) add 1 dices
(**Apply In the case** that the number of dices that you throw are 8~18)

(2) Removing(=Death of Elephant)

i) remove this dice
(**don't apply** for first 10 times)

ii) remove a dice among three '4' dices

iii) remove the dice
(**Apply for two times** after you throw more than 20 dices)

iv) remove the dice

Activity 2 : Seek and propose alternative measures for sustainable population of elephant in Mpya game reserve.

1. Based on the result of each group, Let's seek alternative measures for sustainable population of elephant in Mpya game reserve.

2. After 15min-discussion time, move to another table and discuss with new members.(World café)

Result & Discussion

1. Each HOST announces the ideas to be discussed and proposed in his table.

2. All people listen.

3. If we have enough time, we have Q and A session.

14. Causes that affect the size of the population

Kim Kyoungtae

Ⅰ. Introduction anc Background

The changes in population size is called the population growth curve. Theoretically, it draws a J-shaped curve, but in the natural state it shows an S-shape by environmental resistance. Growth curves alone have difficulties in studying changes in population size. If there are opportunities to observe and record changes in population size, students will have opportunities to analyze the causes on the changes in population size. In addition, observation data are needed to examine the existence of various causes of changes in population size and the effects of human activities. To reflect this, the elephant population restoration project was chosen.

Set up a reserve area(national park or game reserve) to restore elephant population. Play a dice game according to the rules given. Observe and record the birth and death of elephant individual through a dice game. Consider the changes in the size of the elephant population and analyze the causes that affect changes in population size and look for ways to improve sustainable reserve area.

Ⅱ. Objectives

· We can observe changes in population size and graph changes.
· We can find causes that affect the size of the population.
· We can seek alternative measures for sustainable reserve area.

Ⅲ. Materials

· dice(30 dices for 1 group), 1 low basket, work sheet

Ⅳ. Overview

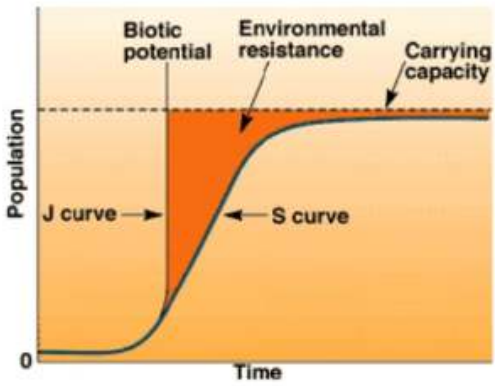
Order	Activity Topics	Time(min)
1	Observe changes in population size and graph changes	30
2	Find causes that affect the size of the popluation	20
3	Seek alternative measures for sustainable reserve area	50

Ⅴ. Procedure

Activity 1 : Observe changes in population size and graph changes

- **Objective** : We can observe changes in population size and graph changes and compare our graph with the theoretical growth curve
- **Materials for group** : 30 dices, 1 low basket, work sheet
- **procedure**

1. We will bring elephants into Mpya game reserve(There are no large mammal in this game reserve). Environmental capacity of this game reserve is 20 elephants and 13 elephants will be coming in. <A>is population growth curve in textbook. Predict the changes of elephant population in Mpya and draw it in <B>. And write the reaseon that you think so.



<A. general growth curve>

<B. Mpya elephant growth curve>

2. Throw dices. Add or remove dices according to the rules. Record the changes in the number of dice in basket. The rules are as follows.

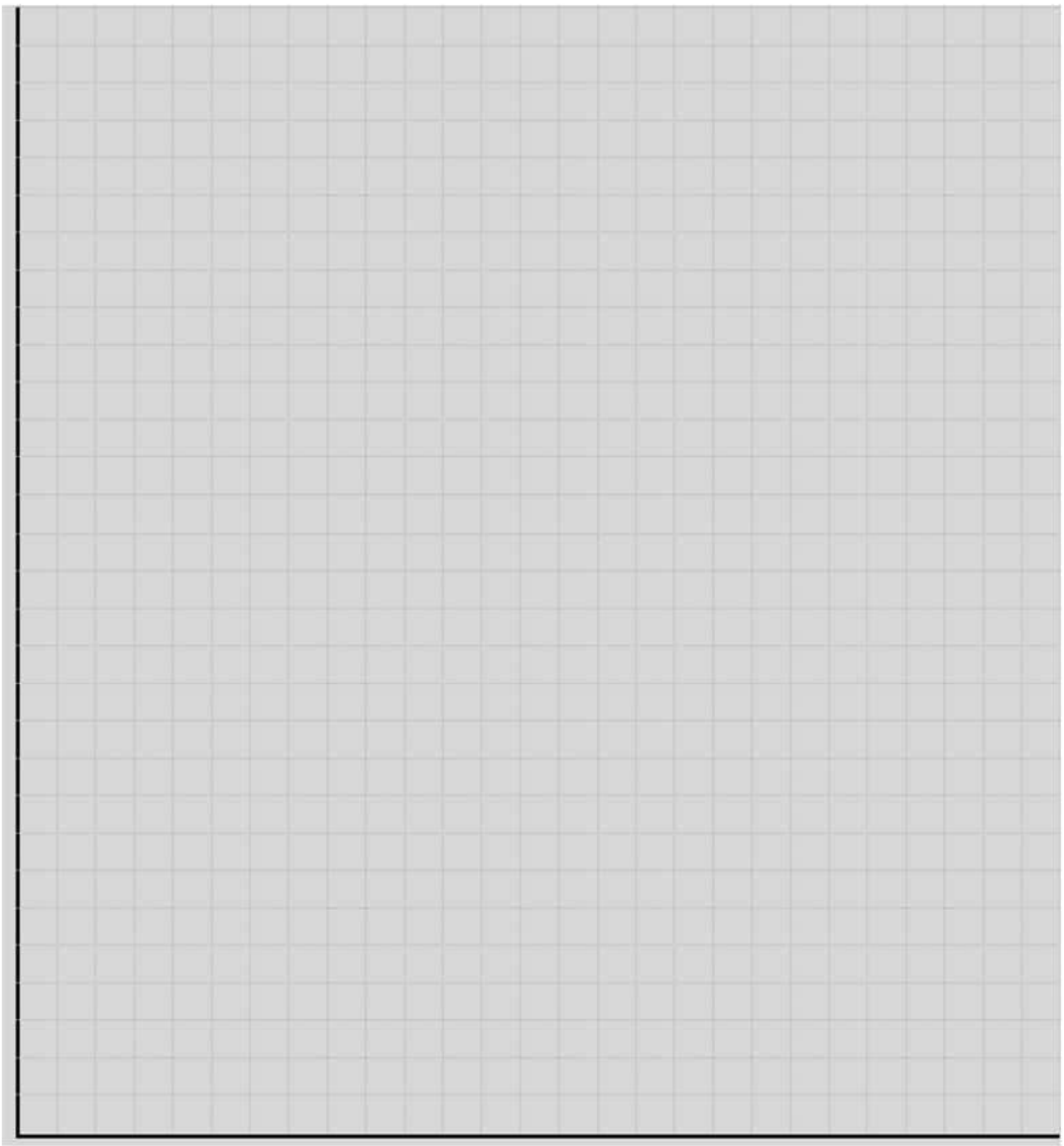
1. Set up
  ① 1 dice means 1 elephant.
  ② The low basket means game reserve. So elephants in basket is alive.
  ③ Adding dice in basket means birth of elephant, Removal of dice means death of elephant.
  ④ Definition of '1 time' is to throw all the dice in basket at once. 3 years pass in '1 time'.
  ⑤ At first, there are 13 dice in basket.
  ⑥ Environmental capacity of this game reserve are 20 elephant.

2. Birth of elephant
  ① Regardless of the size of the population, every dice that represent number 1, add one dice to basket.
  ② If the size of population is 8~18, every dice that represent number 2, add one dice to basket.

3. death of elephant
  ① death by aging
    : remove the dice that represent number 3. (There are no death by aging in 30 years(10 times)
  ② death by diseases
    : if there are three dices that represent 4, remove one dice among three dices.
  ③ death by famine
    : If there are more than 20 elephants(dices) in the basket, there are famine for 6 years(2 times). In the period of famine, remove the dice thbirthat represent number 5.
  ④ death by poaching
    : remove the dice that represent number 6.

Years		0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
Size of population		13																				
Birth (1 or 2)																						
Death	Aging (3)		X	X	X	X	X	X	X	X	X											
	Disease (4)																					
	Famine (5)																					
	Poaching(6)																					

3. Graph the growth curve of elephant population in Mpya game reserve.



<Growth curve of elephant population in Mpya game reserve>

4. Compare predicted growth curve with observed growth curve. What is different? Write the cause of difference.

5. Think and discuss about the causes that affect the size of the elephant population. And write as much as possible.

Activity 2 : Seek and propose alternative measures for sustainable population of elephant in Mpya game reserve.

- **Objective** : We can seek and propose alternative measures for sustainable population of elephant in Mpya game reserve.
- **Materials :** work sheet
- **Procedure**

1. Fortunately, what we observe is not real. It is simulation result. Based on the result of each group, Let's seek alternative measures for sustainable population of elephant in Mpya game reserve. The time for discussion is 15 minutes.

2. Now, one volunteer is left as HOST. Another students visit another table as GUEST. Be careful not to meet students who were at the same group.

3. Each HOST describe the previous discussion. Every GUESTs listen to HOST's description and claim own thoughts.

4. Each HOST describe the ideas on your table to classmates. Listeners can write good idea.

5. Write what you learned newly and what you want to know.

(1) What you learned newly

(2) What you want to knowz

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SCIENCE, TECHNOLOGY AND SOCIETY (STS)

Look, Listen, Learn, Share, DO!

Hands-on, Brains-on, Relate-on

This document offers an introduction to Science and Technology Studies (STS).

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What is STS?

Science, technology and society (**STS**), also referred to as **science and technology studies** (**STS**), is a branch of science studies. It considers how social, political, and cultural values affect scientific research and technological innovation, and how these, in turn, affect society, politics and culture. Also defined as an interdisciplinary study of how science and technology shape society and the environment, and conversely how society and the environment shape science and technology. The intellectual roots of STS lie in philosophy, ethics, history, and social study of science and technology, an arena where often-controversial issues and choices interface with values and influence public policy. STS prepares students to understand both the technical and social dimensions of science and technology, helps them become more thoughtful and better-informed citizens of our high-tech society, and develops their critical interdisciplinary thinking, research, and communication skills. Students flourish intellectually in an environment where critical questioning is encouraged and opportunities for research are abundant.

History of STS

STS is a new subject. Like most interdisciplinary programs, it emerged from the confluence of a variety of disciplines and disciplinary subfields, all of which had developed an interest typically, during the 1960s or 1970s in viewing science and technology as socially embedded enterprises. The key disciplinary components of STS took shape independently, beginning in the 1960s, and developed in isolation from each other well into the 1980s. In the 1970s Elting E. Morison founded the STS program at Massachusetts Institute of Technology (MIT), which served as a model.

The “turn to technology”

A decisive moment in the development of STS was the mid-1980s addition of technology studies to the range of interests reflected in science. The “turn to technology” helped to cement an already growing awareness of underlying unity among the various emerging STS programs.

STS-Professional associations

In Europe, the European Association for the Study of Science and Technology (EASST) was founded in 1981 to stimulate communication, exchange and collaboration in the field of studies of science and technology. Similarly, the European Inter-University Association on Society, Science and Technology (ESST) researches and studies science and technology in society, in both historical and contemporary perspectives

In Asia several STS associations exist. In Japan, the Japanese Society for Science and Technology Studies (JSSTS) was founded in 2001. The Asia Pacific Science Technology & Society Network (APSTSN) primarily has members from Australasia, Southeast and East Asia and Oceania.

Important concepts used in STS

- **Deliberative Democracy (by Joseph Bessette in 1980)**

Democracy is a reform of representative or direct democracies which mandates discussion and debate of popular topics which affect society. Deliberative Democracy is a tool for making decisions. Deliberative Democracy can lead to more legitimate, credible, and trustworthy outcomes. Deliberative Democracy allows for “a wider range of public knowledge,” and it has been argued that this can lead to “more socially intelligent and robust” science. Deliberative Democracy can be traced back all the way to Aristotle’s writings. More recently, the term was coined by Joseph Bessette in his 1980

An ideal Deliberative Democracy balances the voice and influence of all participants. While the main aim is to reach consensus, a deliberative democracy should encourage the voices of those with opposing viewpoints, concerns due to uncertainties, and questions about assumptions made by other participants. It should take its time and ensure that those participating understand the topics on which they debate. Independent managers of debates should also have substantial grasp of the concepts discussed, but must "[remain] independent and impartial as to the outcomes of the process.

- **Pace of innovation**

Pace of Innovation is the speed at which technological innovation or advancement is occurring, with the most apparent instances being too slow or too rapid. Both these rates of innovation are extreme and therefore have effects on the people that get to use this technology.

- **No Innovation without representation**

No innovation without representation is a democratic ideal of ensuring that everyone involved gets a chance to be represented fairly in technological developments. It is the idea that relevant parties have a say in technological developments and are not left in the dark. This ideal does not require the public

to become experts on the topics of science and engineering, it only asks that the opinions and ideas be heard before making drastic decisions,

- **Legacy thinking**

Legacy thinking is defined as an inherited method of thinking imposed from an external source without objection by the individual, due to the fact that it is already widely accepted by society. Legacy thinking can impair the ability to drive technology for the betterment of society by blinding people to innovations that do not fit into their accepted model of how society works. By accepting ideas without questioning them, people often see all solutions that contradict these accepted ideas as impossible or impractical. Legacy thinking tends to advantage the wealthy, who have the means to project their ideas on the public. It may be used by the wealthy as a vehicle to drive technology in their favor rather than for the greater good. Examining the role of citizen participation and representation in politics provides an excellent example of legacy thinking in society. The belief that one can spend money freely to gain influence has been popularized, leading to public acceptance of corporate lobbying.

- **Technosocial**

"Technological action is a social process. Social factors and technology are intertwined so that they are dependent upon each other. This includes the aspect that social, political, and economic factors are inherent in technology and that social structure influences what technologies are pursued. Therefore in today's century technology and society, technology and culture, technology and politics are by no means separate.

- **Technoscience**

Technoscience is the combined total of scientific and technological ideas and activities in their social, political and economic realities (Waseda University,n.d). Modern nation-states and the global economy, itself, could not function if they were not based on technoscience. Every aspect of our lives is permeated by the products of technoscience. It is impossible to understand modern society, without studying the effects of technoscience (Ibid)

In the simplest sense, technoscience is the product of people, and people are social. But it is possible to claim something *much stronger* than this: The social norms of technoscientists affects where they will look, what they will see and what they will say about it (Their worldview.) Technocientists' norms are shaped by their discipline. Basic scientific concepts mean different things in different field (Ibid) s. Professional norms affect the value that technoscientists place on judgments. We find disagreement about what counts as science across time and from place to place. The development of technology is highly social, and depends on the manipulation of social norms

Important terms used in STS:

- **Science**

Science is an organized, hierarchical activity that investigates nature and human nature by experiment and observation. Its goals are explanation, understanding, prediction, and control. It tests its theories by logical, mathematical, and technological means. Science is shaped by social forces and historical change. While seeking objectivity, science also shapes culture.

- **Technology**

The Oxford English Dictionary offers meanings for "technology" as: A discourse or treatise on an art or arts **OR** the scientific study of the practical or industrial arts. *Techne* (art, craft, skill), *Logos* (word).

- **Society**

Society is the result of people, and institutions, interacting with one another. It is a sort of *epiphenomena* of these individuals. Society in turn shapes the people and institutions that form it. Most people experience society as though it were external force acting upon them. The "effects" of society operate through the vague mechanism of social norms. Norms "tell" us what we should and should not do, what we should and should not think. But they are not rational or rather, their rationality is not universal. Norms produce the values that we use in interacting with others. They produce many of our core ideas such as ideas of the place of *class*, the role *gender*, the meaning of *race*, the function of *justice*, the importance of *objectivity*, the criterion of *truth*, the significance of *evidence*, etc.

Some of the questions raised in the component disciplines of STS are as follows:

Philosophy: What is technology? How do we construct scientific knowledge? Are there truths? How do technologies mediate our perception of reality? Are technologies value-neutral? Are technologies merely "tools"? What does it mean for a technology to be *valenced* towards a particular purpose? Are technology and society distinct entities? What is a sociotechincal system? In what ways can society influence the course of scientific research? What is the relationship between science and technology?

History: What are the uses of history? How can we learn from history so we do not repeat the past? How does history help develop humanistic sensibilities that are, or ought to be, a part of scientific and engineering work? How important has technology been to Western societies? How has science and technology changed our economy? How do corporations, national governments, and local governments shape technological development, and what consequences have this had?

Social Studies: Why are women less likely to be engineers? What is the anatomy of environmental racism? To what extent does technology contribute to racial and economic segregation and the decline of the inner city? Does the Internet promise to increase or decrease social inequalities, and how might

changes in the technology reduce or exacerbate this effect? How do technology and consumerism define our leisure? How does technology shape our workplace? Why are women more likely to be engineers today than thirty years ago?

Ethics: What is the purpose of science? How should technology be used? How should we distribute the risks and benefits of science and technology? How should we weigh present benefits against future liabilities? What responsibilities do scientists have for the knowledge they create? What responsibilities do engineers have for public safety? Are engineers "mere employees," or do they have professional and ethical responsibilities, as do doctors and lawyers? What are the limitations of professional ethics? Can there be higher standards for ethics? Would you be willing to abide by them?

Political Science: What is the proper sphere of public involvement? What are the rights of the corporation? What are the rights of individuals? When does public interest outweigh the economic interests of corporations? What is democracy? Does the Tanzania practice a strong form of participatory democracy? What mode or modes of democratic governance do we have in the Tanzania today? Is the regulatory apparatus of our government sufficient to protect our public interests? How can the system of governance be altered for the benefit of consumers? When and under what circumstances can this be justified?

Rationale for teaching STS education

- Science and Technology have profound effects on society:

⇒ Provides products that increase quality of life
⇒ Negative effects of weapons, pollution, etc…
⇒ Students will live in an increasingly technological society and therefore need to understand how these institutions interact
⇒ Our students will have to make informed decisions about these issues

The STS approach to science instruction

- Science for meeting personal needs
- Science for addressing societal issues and problems
- Science for assisting with career choices

STS education, in considering students' personal construction of knowledge, highlights the importance of student's exploration, investigation, inquiry-based learning, discovery learning, knowledge building, creativity, innovation and critical reflection.

The urgent needs for Scientific and Technological literacy

Reforms in science education have continually emphasized the goal of achieving scientific literacy for all students (Bybee, 2010, URT, 2011) Key reform documents (NSTA, 2010), including the most recently released *Next Generation*

Science Standards (NGSS Lead States, 2013), indicate the urgent need for scientific literacy in various arenas in society, including the workforce. With human society becoming increasingly shaped by and dependent upon science and technology, a global awareness of the impact of science and technology upon our living environment is becoming more and more critical.

Teaching science in its social context and helping students both understand and think through the implications of the social nature and culture of science and technology is essential to achieving scientific literacy (NRC, 2013; NSTA, 2010). The STS curriculum enables students to understand the interdependence of science, technology, and society and become empowered to make informed and responsible decisions; and to act upon those decisions (van Eijck & Roth, 2013). This is an aspect of social responsibility. Studies regarding the benefits of STS instruction on student learning have revealed improvements in students' achievement, decision making, attitudes toward science, creativity, questioning abilities, and process skills such as hypothesizing, investigating, and evaluating (Yager et al. 2009). However many citizens are ill prepared to exercise their citizenship rights when faced with complex social issues involving science and technology. As future citizens, students will have the enormous responsibility of making decisions that will impact themselves as well as society. Many of these decisions will require an understanding of the interaction of science and technology and its interface with society.

Main branches of Science and Technology Studies (STS)

I) Health, II) Environment, III) Engineering/Design, and IV) Math and Information Technology

I. Health, Biology, and Society

Reflective questions

Do you think employers should have the right to test people for genetic disease susceptibility, even if they are prohibited from discriminating against them?

Should scientists be allowed to develop the **chimera** (human-animal combination)?

Even if there is no proven risk, should the public have a right to reject GMO crops?

Do you think GMO crops should be banned completely or just subjected to regulations?

Do you think parents have the right to take their children out of chemotherapy (autonomy principle), or do you think the state and medical profession have the right to force parents to put their children on chemotherapy (beneficence principle)?

Even if some people die or have lower sperm counts due cell phone use, isn't worth to have cell phones?

Ii. Environment and society

Reflective questions

What is environmental health?

What is sustainable development?

Is it possible for a society to continue to grow and to be sustainable?

Given what you currently know from the reading and other sources, do you think there is evidence that greenhouse gases are causing global warming?

Describe how different organisms need specific environmental conditions to survive (Diversity)

III. Engineering, design, and society

Reflective questions

In your locality (ie. Buchosa) what would you make as priority design?

Why build highways through cities? Would cities be different if the bus stations were at suburban locations, with rail links within the city?

Is access to transit_a basic right, similar to health care?

How can public transit be designed to be both more environmentally sustainable and less susceptible to terrorist attack**?**

IV. Mathematics, Information and Society

How would you define privacy?

What kind of regulation should there be on private firms' databases on persons?

What do you think of the argument that privacy in the sense of data gathered about you when you surf the Internet should be a commodity, not a right?

Which is a worse threat, little brother (private sector databases on your personal information) or big brother (government databases)?

If an operating system code is publicly available, wouldn't it be more prone to terrorist attack?

How serious do you think the problem of consolidation and vertical integration of media is in terms of a threat to democracy?

Can we have a democracy without a free and independent media?

Can the Internet solve the problem or is it subject to the same consolidation process?

How would you restructure public broadcasting to make it more independent and vigorous?

How would you develop more vigorous local/community media?

Integrated STS

Science and Technology Studies (STS) integrate with other relevant approaches such as:

- Science, Technology, Engineering and Mathematics (STEM)
- Science, Technology, Engineering Arts and Mathematics (STEAM)

Science, Technology, Engineering and Mathematics (STEM)

STEM Integrates the study of Science, Technology, Engineering and Mathematics. Uses Scientific Inquiry and Engineering Design as unifying themes and Emphasizes on:

- Critical thinking and problem solving
- Communication
- Collaboration
- Creativity and innovation
- Laboratory investigations
- Research projects
- Real-world experiences via work-based learning opportunities

“If we’re not creating something with our knowledge, we’re just memorizing it and
not applying it in any real way.” Lindsey Own

"Design is not just what it looks like and feels like. Design is how it works."
- Steve Jobs, former CEO of apple, inc.

STEM education program may include curriculum from career clusters other than engineering and computer science (i.e. **healthcare** science, **agricultural** science, **biotechnology**, and **food and nutrition** science)

Science, Technology, Engineering Arts and Mathematics (STEAM)

STEAM education is similar to STEM, except with additional of Arts

Arts- Studies intended to provide general knowledge and intellectual skills (rather than occupational or professional skills) (source: word web dictionary) or (arts) subjects of study primarily concerned with the processes and products of human creativity and social life… (Oxford American Dictionary).

Art + Design provide real solutions for our everyday lives, distinguish our products in a global marketplace, and create opportunity for economic growth.

"After a certain high level of technical skill is achieved, science and art tend to coalesce in esthetics, plasticity, and form. The greatest scientists are always artists as well." —Albert Einstein 1921

✓ **Fine Arts Strand: Visual Arts**

- Create original works of art using a variety of visual arts materials, techniques, and processes.

- Understand and apply art materials, techniques, and processes in the creation of works of art and understand how the visual arts communicate a variety of ideas, feelings, and experiences.

- Create an original integrated art product or performance and explain how this process enhances a specific art work

- Use the elements and principles of art and design, such as emphasis, proportion, complementary colors, positive and negative space, and depth, to communicate an idea or mood.

STEM/ STEAM education's integration of hands-on, real-world learning tasks, coupled with academic theory, helps student's master rigorous math and science concepts

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THE E5 MODEL

Introduction
An instructional model, or learning cycle, is a sequence of stages teachers may go through to help students develop a full understanding of a lesson concept. Instructional models are a form of scaffolding, a technique a teacher uses that enables a student to go beyond what he or she could do independently. A scaffold is a temporary structure that is established for support but can be removed once the task is complete. An example of an instructional model is how effective caregivers use familiar scaffolding techniques, such as those listed below, to teach even young children (Wood, Bruner and Ross 1976):

- interest the child in the task
- simplify the task so that the child can manage it
- motivate the child to keep trying
- gently identify differences between what the child has produced and the ideal solution
- control frustration and risk
- demonstrate the process

An instructional model is a scaffold that is planned and developed prior to instruction to provide an effective and efficient learning experience. Some instructional models are designed for a particular learning theory, such as behaviorism, cognitivism, or constructivism. Some combine aspects of different learning theories. The 5E instructional model, developed by Rodger W. Bybee in the 1980s, was designed specifically to provide a model that promotes a constructivist approach to science education while incorporating aspects of behaviorism and cognitivism. The model has been widely adopted by science educators and is useful in other subject areas as well..

The Original 5E Instruction Model

The 5E instructional model has been used since the late 1980s. It falls within the theories of constructivist teaching model (Bybee 2006). Every element of the five "Es" is carefully crafted to promote student construction of knowledge.

1. **Engagement**—Access prior knowledge and engage the new concept through short activities that promote curiosity.

2. **Exploration**—Provide a common base of activities in which current concepts are identified and conceptual change is facilitated.

3. **Explanation**—Focus on a particular aspect of engagement to provide opportunities to demonstrate conceptual understanding, process skills, or behaviors. This phase also provides an opportunity for teachers to directly introduce a concept, process, or skill to guide students toward a deeper understanding.

4. **Elaboration**—Challenge conceptual understanding and skills through new experiences to develop deeper and broader understanding and application.

5. **Evaluation**—Students assess their understanding and teacher evaluates student progress

toward educational objectives.

Constructivism, in general, has been criticized for not promoting a foundation of knowledge, but the 5E model incorporates aspects of the behaviorist and cognitivism models, as well.

Engage
The Engagement phase of the 5E Model is the attempt to activate prior knowledge to discover student preconceptions. Preconceptions, misconceptions or naïve conceptions are prevalent in our society and are often immune to traditional instruction. Many people, for example, attribute the change of seasons to Earth periodically moving closer and farther in distance from the sun, rather than to the changing tilt of Earth on its axis. Prior knowledge has been shown to be a major factor in comprehension in any subject. Effective instruction must take into account the knowledge that students already have. In science, when students reveal their prior knowledge, any naïve conceptions are exposed. Recent work in using prior knowledge at the base of an analogy for a lesson's science concept helps to build understanding throughout the lesson and has been shown to be highly effective in developing science expertise. (Clement and Stephens 2008).

There are many ways to activate prior knowledge including:

- Brainstorming (listing information solicited from students).
- Asking specific questions and noting responses.
- Engaging students in a problem, activity, or scenario to elicit what they know.

Explore
The Exploration phase of the 5E model challenges student preconceptions. “Creating an opportunity to challenge our students to call on their collective experiences (prior knowledge) is essential. Through this process we move students from memorizing information to meaningful learning and begin the journey of connecting learning events rather than remembering bits and pieces. Prior knowledge is an essential element in this quest for making meaning. “ *(Christen and Murphy 1991)* Four conditions need to be present in order for students to undergo a conceptual change (Mestre 1994):

1. Student dissatisfaction with an existing conception. (If an explanation makes sense to the student and is unchallenged, there is no motivation to change it.)

2. Students must have some minimal understanding of the concept or they will not appreciate its meaning.

3. Students must view the new concept as plausible or they will not give it serious consideration.
4. Students must see the new concept as useful for interpreting or predicting phenomena.

To create these conditions, teachers must do the following:

- Listen to student ideas to identify misconceptions.
- If misconceptions are identified, promote dissatisfaction by challenging students; they can do this by providing evidence that illustrates inconsistencies between student beliefs and scientific phenomena.

- Inspire debate about the evidence to help students appreciate the value of the scientific conception in terms of its consistency with other concepts and phenomena.

- Help students to reconstruct their knowledge.

- Through exploration including discussion, demonstration, and hands-on activities teachers can challenge student conceptions.

Explain
The Explanation phase involves presenting information that students are unlikely to discover on their own and allows for students to demonstrate skills, knowledge, or behavior. This phase provides the teacher the opportunity to address concerns that students might miss the point of the lesson, may experience cognitive overload, or without instruction might even develop misconceptions. The foundation of knowledge is critical to developing expertise (Bereiter and Scardamalia 1993). Without the explanation and relaying of content knowledge, many students—particularly weaker students will not benefit from the lesson or activities, no matter how engaged they are.

Extend
Extending or elaborating on content is the next phase of the 5E Instructional Cycle. This phase reflects Elaboration Theory, which emerged from Cognitivism Learning Theory. The premise is that for the most effective learning to take place, instruction should be organized in increasing order of complexity. The idea is that students need to develop a meaningful context into which new learning can be connected. In this phase of the 5E Instructional Model, supporting content—including information, understandings, and skills that are directly relevant but have not been addressed can be elaborated on.

Evaluate
Evaluation is a critical phase of any instructional model. The purpose of *formative* assessment during instruction is to provide information about student understanding and performance to enable the teacher to make course corrections as need be, based on sound, defensible decisions (Anderson 2003). A *summative* assessment following instruction provides for evaluation of performance, but can also inform the instructor about how to manage subsequent lessons. A key factor in any assessment is that it is valid: that it enables the instructor to gauge if and how students are meeting the lesson objectives. Evaluations may take the form of quizzes, tests, observations of performance, writings, interviews, or some other form. Without a valid assessment neither instructors nor students can be confident that objectives are being addressed and met.

Using the E5 model of instruction

Teacher Expertise: Instructional models are only effective if they are used by effective teachers. The instructor must be prepared to make decisions about each of the following:

- Which activities will best engage students in a lesson?

- What preconceptions do students have?

- How can preconceptions be challenged?

- What explanations do students need?

- When and how can the lesson content be meaningfully elaborated?
- How can student understanding be validly assessed?

Expert teachers have a firm understanding of their respective disciplines, knowledge of the conceptual barriers that students face in learning about the discipline, and knowledge of effective strategies for working with students. Teachers' knowledge of their disciplines provides a cognitive roadmap to guide their assignments to students, to gauge student progress, and to support the questions students ask. The teachers focus on understanding rather than memorization and routine procedures to follow, and they engage students in activities that help students reflect on their own learning and understanding. An effective instructional model such as the 5E Instructional Model, along with effective instructional materials, is tools and resources for educators that can play a substantial role in providing quality instruction and education.

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WORLD CAFÉ

What is a world café?

The World Café1 is a simple yet sophisticated method for holding meaningful conversations around important questions in large group meetings. An excellent tool to encourage participant interaction, the World Café can foster deeper engagement with complex or challenging issues During advance planning, for each World Café session, an overall topic is set; within that topic, 3 - 5 key questions are formulated for discussion; and each question is assigned to a specific table host (an expert or someone with strong interest in the question).

At the event, 3 - 5 tables (one per question) are set up in 'café' style to create a relaxed, informal ambience). Participants divide and choose (or are assigned to) a table to start the process. The host provides a brief introduction, and then participants discuss the question. When time is up, the participants rotate to the next table, while the host stays behind to introduce the question once more and summarize the preceding discussion for a new set of participants. The new participants then add their insights to the question, refining or modifying the contributions of the previous group. This step is repeated until participants have had the opportunity to discuss up to three different questions/issues. A concluding plenary wraps up the discussion. By dividing a large group into smaller subgroups, conversations can be made more focused, relaxed and participatory, with greater opportunity for all participants to speak and contribute equally – thereby encouraging authentic sharing of experiences and knowledge. Rotation of groups from one table to the next adds value to the discussion, by allowing a group to build on the previous group's thoughts and ideas about a particular issue.

Requirements:

- Facilitator
- A host and a rapporteur per table
- 12 - 30 participants
- 3 - 5 tables (ideally round) and sufficient chairs for all participants
- One flipchart per table, plus marker pens
- Optional: Flipchart paper to cover the tables (in addition to the standing flipchart); Post-it notes or VIPP cards; marker pens (multiple colours) for participants
- Bell or alarm clock for timekeeping
- 75 - 90 minutes (including concluding plenary)

How to apply the world café

1. Identify the topic of interest, and craft 3 – 5 specific questions or burning issues for discussion. The key success factor of the World Café is the questions. Formulate the questions or issues to be thought-provoking. For each one, ask yourself whether it piques the interest of participants enough to encourage lively discussion and even to inspire some to step forth as champions or detractors. Keep questions simple, clear and most of all open-ended so they will easily inspire inquiry and lively exchange. Ideally, all the questions should be interrelated, so that they will encourage a flow and logical progression of thoughts. Ideally there should be 3 - 5 questions, one per table enough for a minimum of 3 rotations among tables. Questions/issues should not be highly complex, as this is a rapid exercise. Ideally, they should be able to be explained in 2 – 3 minutes.

2. Identify one host per question/table (in advance), and brief them on the responsibilities which they will have at the event. The hosts can be experts in the particular question, or people with a particularly strong interest in it. Their responsibilities will include:

- To provide a 2 - 3 minute introduction to each group of participants, on what the question is about, why is it important/relevant, etc
- To manage the conversation, sustain the energy levels of the group, spur it on when there is a lull, and encourage balanced participation among the group members.
- To remain at the table when the others move on, and brief the arriving groups about the highlights from the earlier conversations.
- To provide a quick overview of key contributions from the table, during the plenary wrap-up.

3. Identify also who should participate in order to have a fruitful discussion, and invite them to the session.

4. Set up 3 - 5 tables, one per question (or set up a similar number of discrete working areas with simple circles of chairs). Work within a single room rather than using breakout rooms: This is a technique which involves multiple small teams working in parallel, but there needs to be a "buzz" from the group in its entirety to keep the overall energy in the room high.

5. Cover the tables with white flipchart paper (or paper tablecloths, if available) and provide marker pens in multiple colors. The paper is for participants to write, draw, or doodle in the midst of the conversation. Alternatively, advise the table host to encourage the group to write down their ideas on VIPP card/post-its and collect them before rotation.

6. Group the participants among the tables, randomly or strategically if required with equal numbers of about 4 – 6 participants per table.

7. Brief the participants on how the event will unfold:

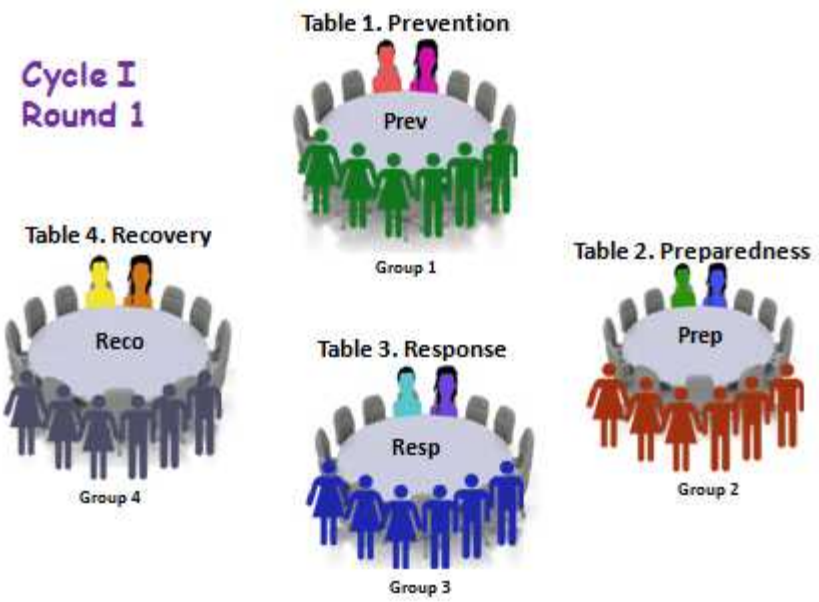
- **Each table will choose a rapporteur**, who will stay behind with the host when others move on, and who will take notes. Ensure that each group uses the same method of recording their discussions, such as a flipchart or computer based note-taking. Otherwise it can be more difficult to aggregate the outputs of the groups into a coherent product at the end.

- **After a 2 - 3 minute introduction by the table host (e.g., what the question is about, why is it important/relevant, etc.), participants will begin the discussion** by sharing their insights and suggestions on the question/issue laid before them, listening to each other and asking questions for clarification. Table hosts will play their facilitative roles (as per the responsibilities outlined in #2 above).

- **While they discuss, participants are encouraged to write ideas on the flipchart paper (or paper tablecloth) that covers the tables**, so that the next group that visits the table will be able to gather impressions from it. The rule has to be that they can't write something down until they have shared it out loud first, so that the host and rapporteur can also take note. This helps the conversation to be faster-paced and the record more accurate as people write in their own words.

8. Begin the discussion. Each round of the World Café should take approximately 20 minutes; keep track of time and emphasize that there is no time to waste.

9. When time is up, use an alarm clock or a bell to signal to participants to wrap up their conversations and move to the next table. Instruct them on the order of movement, i.e., to the left or right, clockwise etc. Everyone at a table is to move to the next table, except for the host and rapporteur, who remain behind to welcome the new group and to share a quick summary (3 - 5 minutes) of the earlier session. Discussion then proceeds for about 15 minutes. Once again, signal participants when time is up



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10. After 3 rounds of café conversations are completed, invite all groups to join in a plenary session for reflections on the topic and questions. Invite the hosts of every table to provide a 5-minute summary of key points and insights from the conversations that have taken place. Capture key findings on a separate flipchart, if the host has not already done so. This is a good time for any person who has not been able to join a specific table discussion to add their thoughts or comments on the topic.

11. Conduct a quick debrief of the World Café method by asking participants for feedback on how it has worked for them, what they liked and what can be improved for the next time.

12. Write a summary of the main insights from the discussions and share with participants afterwards as appropriate, as part of the minutes of the workshop or as a stand-alone document. This summary provides a useful output from the World Café in those sessions where it is important to capture in detail the feedback and contributions from participants.

VARIATIONS

There are many variations to the World Café:

- ✓ **Different physical arrangements:** The setting can be elaborate, with round tables, snacks and drinks, or as simple as a circle of 4 chairs. At locations without any tables, one can use chairs to set up a group conversation, and participants can make notes or scribble on A4 instead of flipchart paper.

- ✓ **Open groups:** In this variation, the first round of the World Café is organized and conducted as usual. But then in the second round, the rotation is thrown open: participants can move to any other table of their choosing, regardless of the numbers in the group. The same open rotation applies in the third round. Hosts and rapporteurs still play their usual roles.

- ✓ **Parallel sessions:** One way to apply the World Café effectively in larger groups (50 – 60 people) is to hold two parallel World Cafés with 4 - 5 tables in each. Each session should use the same questions across its tables. How different groups address the same questions should make for interesting comparisons. However, holding parallel sessions will require a larger space, extra time at the concluding plenary and more facilitators. If you use parallel World Café sessions, then **ensure that each group uses the same methods for recording the discussions** (e.g. a flipchart, computer-based note-taking, group members writing on cards, etc.) This will greatly facilitate aggregating and/or comparing the outputs of the various groups.

- ✓ **Pre-determined groups:** By preselecting table groups according to expertise, interest or language, the café conversations take on a more focused nature. While there may not be much diversity of ideas in the first round, the subsequent rounds should more than make up for this

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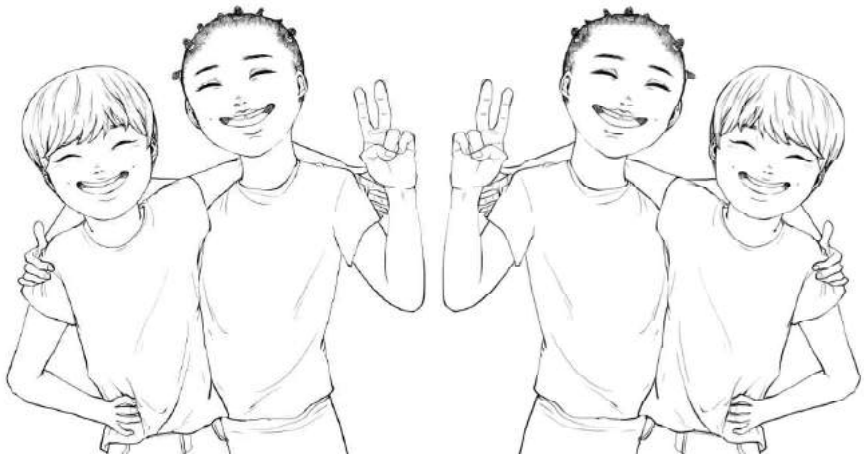

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