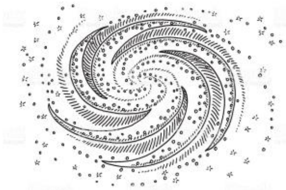
LESSON 1

Name: ___________________________ School: _________________________________



OUR HUGE SOLAR SYSTEM

Create your own scale model of the planets and their orbits around the sun

Materials:

- The planet templates in this lesson
- Scissors
- A few rolls of toilet paper
- A long space outside

Procedure:

1. Cut out the planet templates on the following pages. Each planet's size is scaled in relation to the other planets.
2. Bring your planets and toilet paper outside and place them on the ground, according to the table below.
   - You'll need to "imagine" the sun (**maybe your house can represent the sun**), since the scaled paper sun template would have a diameter of 7 feet, 4 inches!
   - The table below gives you the average (mean) distance from the Sun for each planet, along with the number of sheets of toilet roll (to the nearest whole number) required to model this distance where 1 sheet is the equivalent of 10 million km!

OBJECT	MEAN DISTANCE FROM THE SUN (km)	NUMBER OF SHEETS FROM THE SUN	NUMBER OF SHEETS FROM THE PREVIOUS PLANET
Mercury	57,909,175	6	6
Venus	108,208,930	11	5
Earth	149,597,890	15	4
Mars	227,936,640	23	8
Jupiter	778,412,020	78	55
Saturn	1,426,752,400	140	62
Uranus	2,870,972,200	290	150
Neptune	4,498,252,900	450	160
Pluto	*5,906,380,000*	*590*	*140*

NOTES ON THE TABLE: • Pluto has been included in this table, largely for interest for although it was discovered in 1930, and long considered to be the ninth planet in the Solar System, as we delved deeper into space we found a number of similar worlds in an area called the Kuiper Belt, still within our Solar System. In 2006, after classifying the term 'planet', the International Astronomical Union (IAU) reclassified Pluto as a dwarf planet. • While it is relatively easy to create a model to show the relative distances of the planets from each other and the Sun, it is much harder to then include accurate representations of the sizes of the planets too. To give an example, our biggest planet, Jupiter is a mere 140,000km across, which working to the scale of 1 sheet of toilet roll to 10million km means Jupiter would be just over a tenth of size of a piece of toilet roll!

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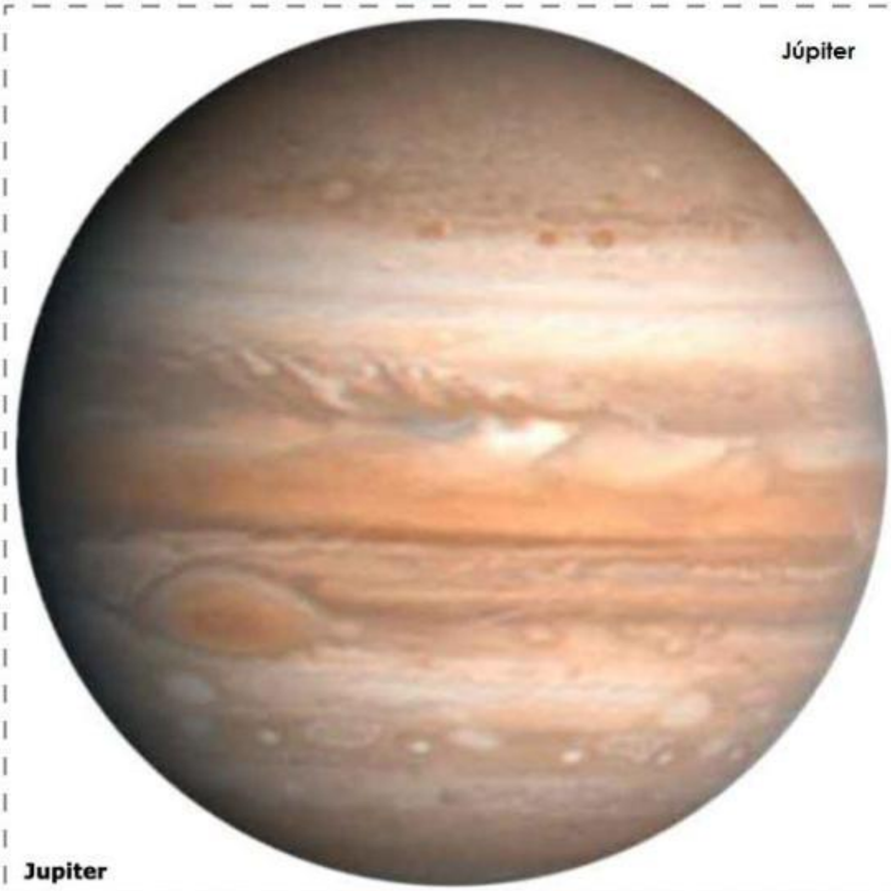
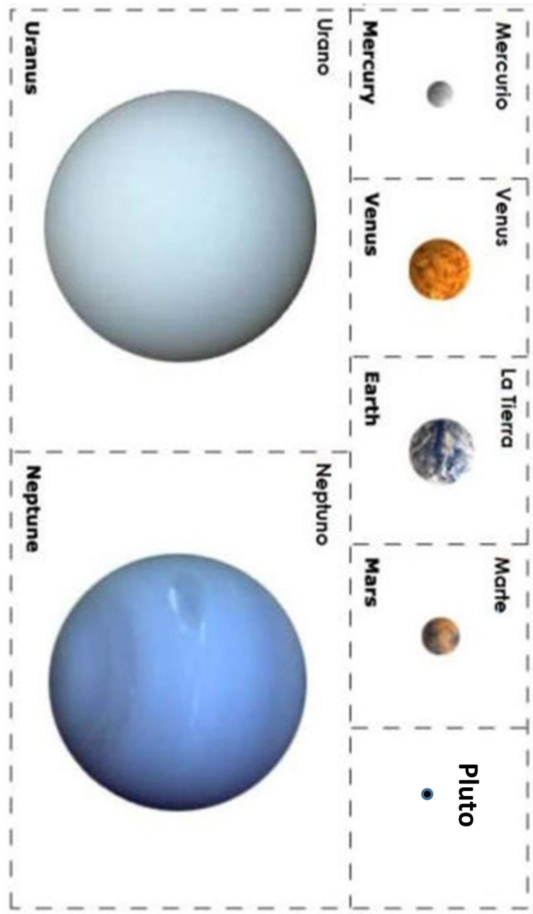
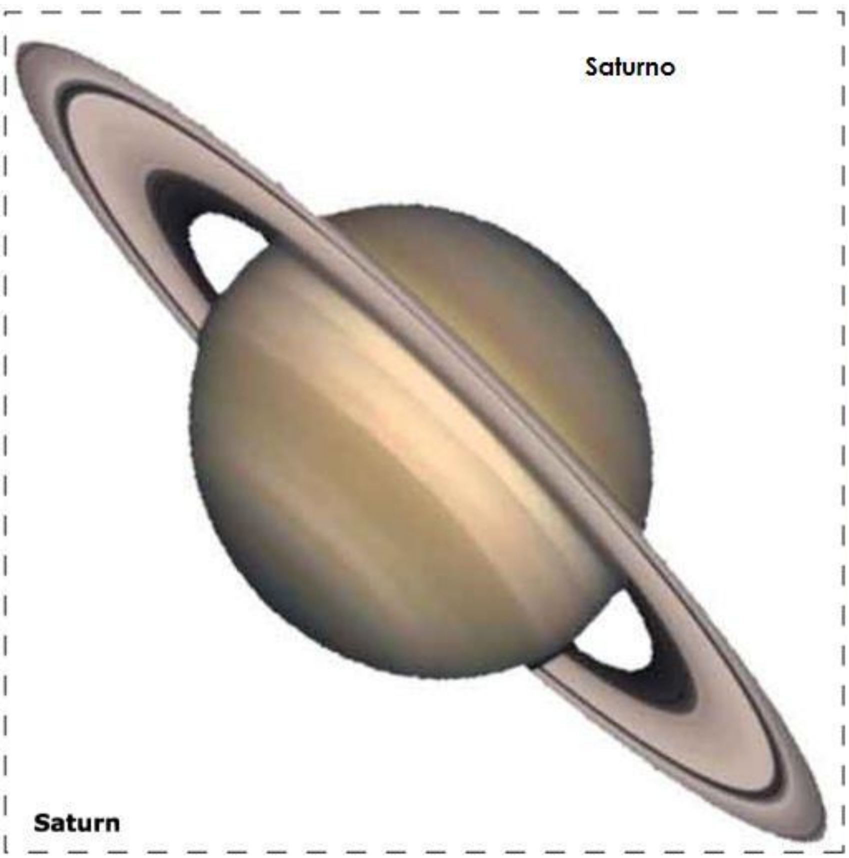
BACK OF PLANET CUTOUTS ON PAGE 3

LESSON 1







ONLINE RESOURCES:

Watch This Guy Build a Massive Solar System in the Desert:
https://www.youtube.com/watch?v=Kj4524AAZdE

INFORMATION ABOUT THE SOLAR SYSTEM:

http://solarsystem.nasa.gov/index.cfm

http://science.nationalgeographic.com/science/space/solar-system

INFORMATION ABOUT SCALES/RATIOS:

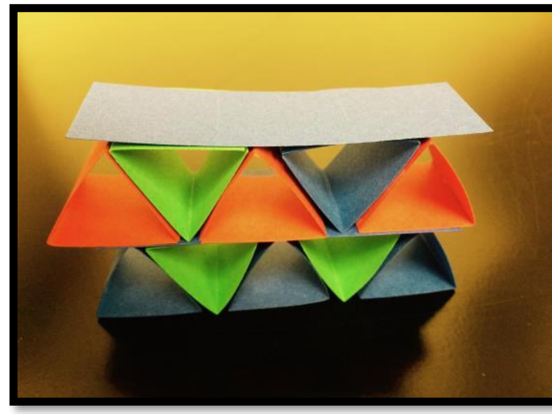
http://hubpages.com/hub/telia-mathshelp

https://scaleofuniverse.com/

LESSON 2

PAPER PHYSICS BLOCKS

Build simple triangle building blocks and learn about physics by assembling a variety of structures.



Guiding Questions:

1. *List some human-made structures that use triangles.*

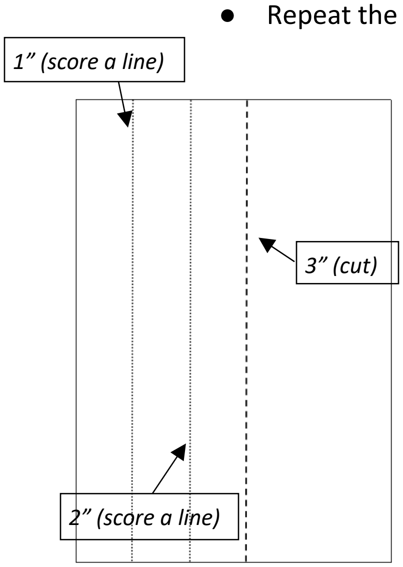
2. *The triangle is the strongest geometric shape. Draw your best triangle and write inside of the triangle why you think it is the strongest.*

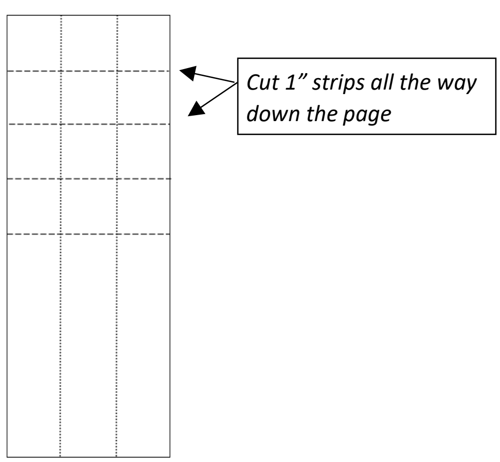
Materials:

- Plain white paper (*OPTIONAL: Different colors of construction paper)*
- Scissors and ruler paper cutter
- Scissor blade or letter opener for scoring paper
- Tape

Procedure:

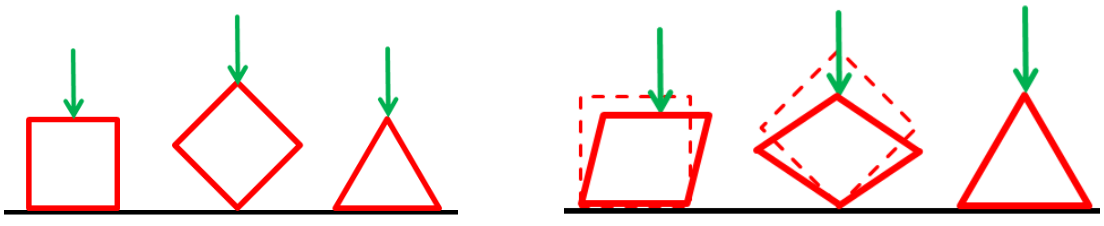
- Choose one piece of paper. Using your sharp edge (letter opener or scissor blade), carefully score the paper vertically at the 1 inch and 2 inch marks, then cut it at the 3 inch mark. Best to have an adult do this, if possible.
- Cut some strips of paper that are 1 inch wide x 3 inches long. These will be used as planks to distribute the weight.
- Fold the scored strips along the lines and tape the open edges together to form little triangles.
- Repeat the process to create at least 20-40 blocks (*OPTIONAL: Make different colors).*





Why are triangles the strongest shape?

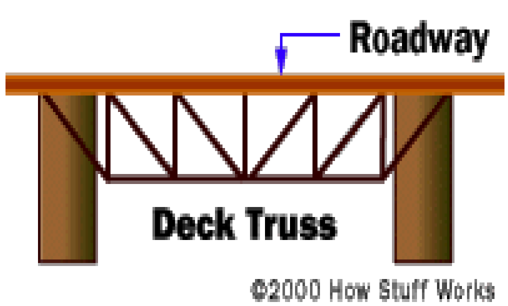
If you push down on top of a square, it will no longer be a square, but instead takes the shape of a rhombus, which is a type of parallelogram. This is called "racking." If we push down on the top of the diamond, it collapses down. But what about the triangle? The triangle maintains its shape!



The reason that the square and diamond collapse is because the angle between the structural members can change without having the length of the members change or bend. Both quadrilaterals simply require the sum of the interior angles to equal 360 degrees, but each angle can change. The angle between two sides of the triangle is based on the length of the opposite side of the triangle. The angle "a" is fixed, based on the relative length of side "A." Just like the angle "b" is fixed based on the relative length of "B" and "c" based on "C." This is why a triangle cannot collapse!

What happens when you try to balance an object on your structure without the plank? Why does it help when you add the plank?

When the triangles are stacked and an object is placed on top of them, there is nothing present to distribute the weight evenly and the triangles will separate and fall. But the plank transfers the load. Think of a truss bridge, which has the ability to dissipate a load through the truss work. The design of a truss, which is usually a variant of a triangle, creates both a very rigid structure and one that transfers the load from a single point to a considerably wider area. In this case, the plank on your structure resembles the road on a truss bridge.



Reflection:

What if someone came to you and asked you to build a bridge out of paper? Would it be possible? How would you do it?

Why do bridges use triangles? Where are some bridges in your town? Where are there triangles in your house?

MORE LEARNING:

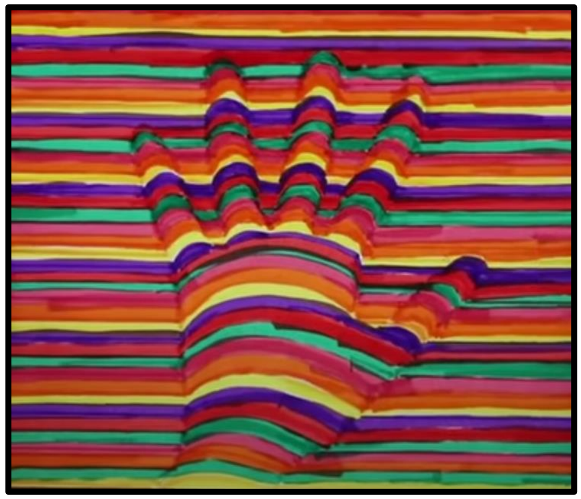
Triangles and Trusses: https://www.teachengineering.org/lessons/view/cub_trusses_lesson01

Physics of Bridges: http://science.howstuffworks.com/engineering/civil/bridge.htm/printable

MAKE AN OPTICAL ILLUSION

Materials:

- Paper
- Pencil
- Ruler or straight edge
- Colorful markers



What are Optical Illusions?

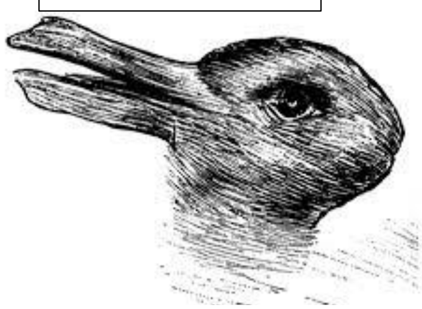
Pick an object in the room and stare at it. What do you notice about the object? What shape and color is it? All the observations that you make about the object are results of your **eyes and brain working together**. The object that your eyes see is interpreted by your brain so that you can understand and describe what you are looking at. Sometimes, the images that we see are perceived in a different way by our brains. These are known as **optical illusions**. Optical illusions use light, patterns, and color to create images that trick your brain.

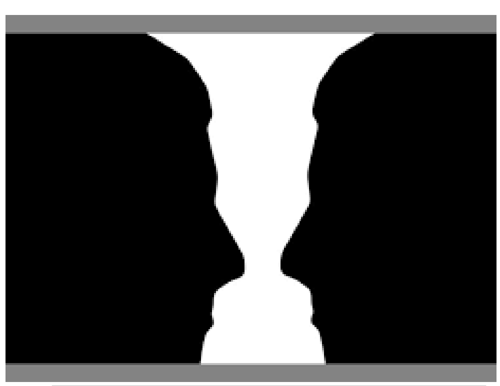
Basically, the messages that your brain is sending you about the image is not what the eye is truly seeing. This can make it tricky for you to tell what is real and what is just an illusion. Sounds like magic, huh? Well, it's actually science!

When you look at an object, you are seeing the light that bounces off the object and into your eye. It takes less than a second for your brain to process this information. This might seem like a short amount of time, but **it is all that the optical illusion needs to be able to trick us. In that amount of time, optical illusions tell our brain to focus on parts of the image that aren't really there.**

OLD WOMAN OR YOUNG WOMAN?

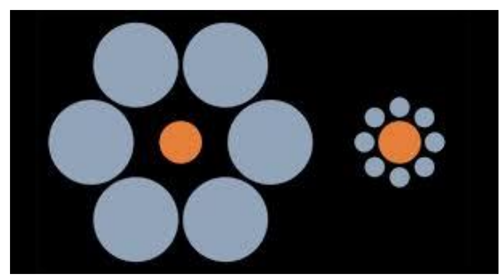
RABBIT OR DUCK?

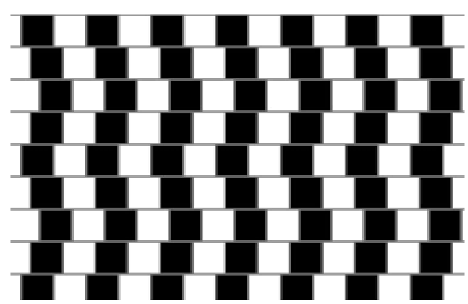




TWO PEOPLE OR VASE?

BOTH ORANGE CIRCLES ARE SAME SIZE!



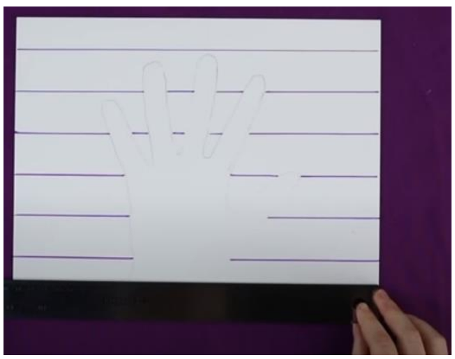


THE LINES ARE PARALLEL!

Procedure:

- Trace your hand.

- Using the ruler, draw straight lines across the page, but skip where you drew your hand.



- Keep drawing different colored lines.

- Draw thick lines between the thin lines, and make it curved where the outline of your hand is.

History of Optical Illusions

The idea of optical illusions has been around for hundreds of years. A writer and philosopher (a person who studies the world and comes up with their own theories about life) named Epicharmus was one of the first people to explain that our senses can trick us even if our mind understands everything clearly.

In ancient Greece, optical illusions began to make an appearance in architecture. Greek temples were built to appear horizontal, but they were actually built at a slant.

In the early 1900s, optical illusions made their way into cartoons. A man named W.E. Hill drew a famous optical illusion cartoon that combines an old woman and a young woman. Some people see the old woman first, while others see the young woman first.

In the 1960s, optical illusions became very popular in a new genre of art called 'Op Art.' In the 1990s, image in Magic Eye books would reveal hidden 3-D images after staring at the image for a few seconds.

LESSON 4

CRACKING CALCULATOR CODES

◆◆

Using this calculator keypad, match the arithmetic problem to the calculator code. After completing the problems, check your work with a calculator similar to the one pictured.

CM	RM	M-	M+	C
7	8	9	÷	CE
4	5	6	×	√
1	2	3	−	+/−
0	.	%	+	=

Example: $^-7 \times 4 = {}^-28$

Calculator Code: [CM] [C] [4] [M+] [7] [+/−] [×] [RM] [=]

Problems: Write in a code letter from below.

_____ 1. $^-4 \times 7 =$

_____ 2. $^-4 + 7 =$

_____ 3. $^-4 - 7 =$

_____ 4. $^-7 + (^-4) =$

_____ 5. $^-4 - (^-7) =$

_____ 6. $4 \times (^-7) =$

_____ 7. $4 + (^-7) =$

_____ 8. $4 - (^-7) =$

_____ 9. $28 \div (^-7) =$

_____ 10. $28 \div (^-4) =$

Calculator Codes: Assume [CM] and [C] are pressed before each code.

A. [4] [+/−] [M+] [7] [+/−] [+] [RM] [=]

B. [4] [+/−] [−] [7] [=]

C. [7] [+/−] [M+] [2] [8] [÷] [RM] [=]

D. [4] [+/−] [×] [7] [=]

E. [7] [+/−] [M+] [4] [+] [RM] [=]

F. [7] [+/−] [M+] [4] [+/−] [−] [RM] [=]

G. [4] [+/−] [M+] [2] [8] [÷] [RM] [=]

H. [4] [+/−] [+] [7] [=]

I. [7] [+/−] [M+] [4] [−] [RM] [=]

J. [7] [+/−] [M+] [4] [×] [RM] [=]

Upcycled Planters and Found Poetry

Make a self-watering planter from recycled bottles and a found poem from recycled magazines and newspapers. Explore how artists and scientist re-use and improve materials through appropriation.

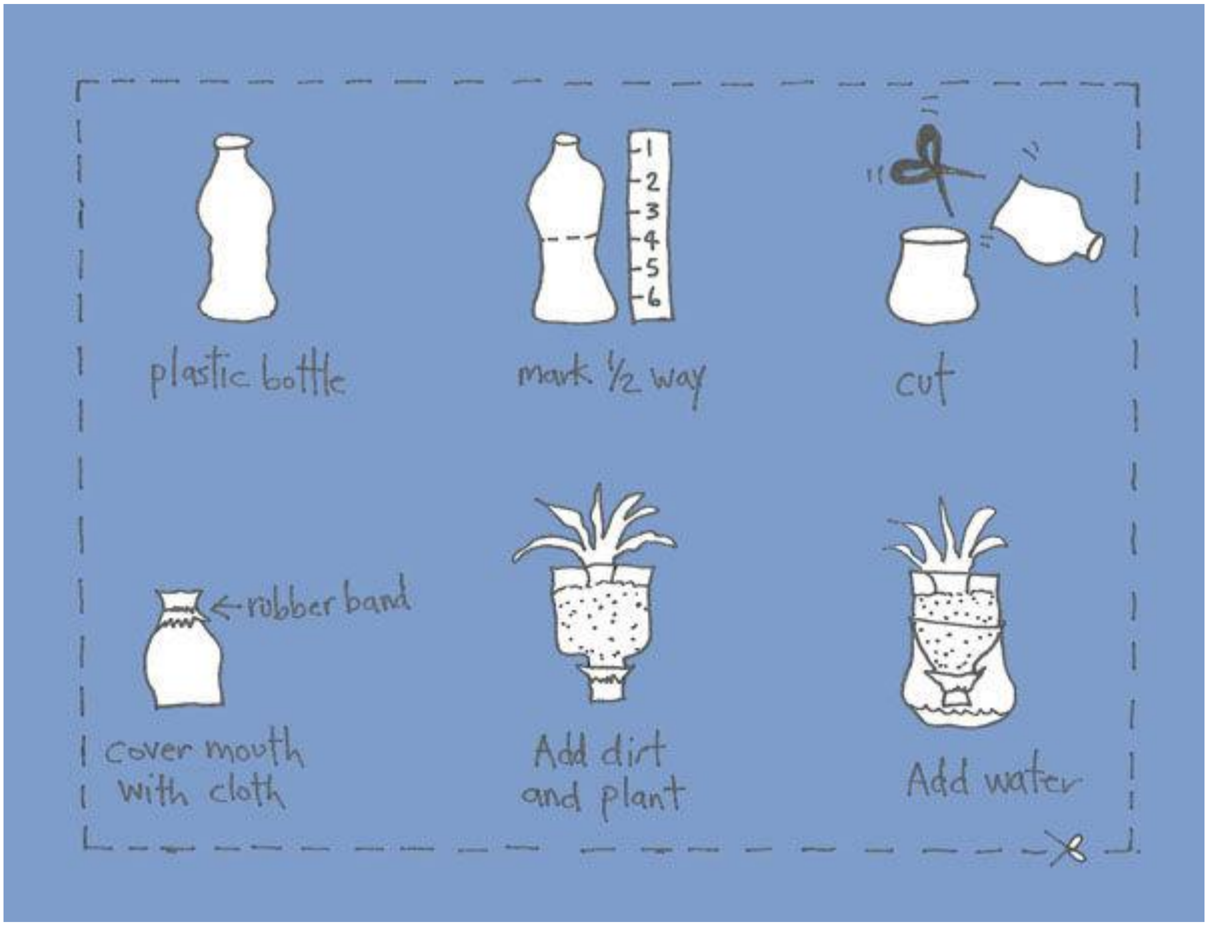
Guiding Questions:

- What is upcycling?
  - Definition: known as creative reuse, is the process of transforming by-products, waste materials, useless and/or unwanted products into new materials or products of better quality or for better environmental value.
- What is a found poetry?
  - Definition: is a type of poetry created by taking words, phrases, and sometimes whole passages from other sources and reframing them as poetry (a literary equivalent of a collage) by making changes in spacing and lines, or by adding or deleting text, thus imparting new meaning.

Materials:

- Used plastic bottles
- Scissors
- Old magazines and Newspapers
- Old fabric (about a 2" diameter circle)
- rubber band
- Potting soil (3 cups)
- A starter plant or seeds (herbs work best)
- Water
- Glue

Making the Planter:



Activity # 2: Found Poetry 20 minutes

1. Choose and interesting passage or two of prose from your old newspaper or magazine, and look for words that stand out in the newspaper. ***Prose: Written or spoken language in its ordinary form, without metrical structure.*** Underline words and phrases that you find particularly powerful, moving, or interesting that relate to the following themes:
    a. Hope
    b. Dreams
    c. Wishes
    d. The future
2. On a separate sheet of paper, make a list of the details, words and phrases you underlined, keeping them in the order that you found them.
3. Cut out the words you underlined and lay them on your table in order (reference the list you wrote in step 2 if they get mixed up).

4. Glue the cut out words on the exterior of your plastic bottle planter. When gluing, spread the glue on the back of the newspaper and stick it to the planter. Once it is on the planter, spread some glue on top of the newspaper to help it be very secure.
5. Now when you water your plant, you can think of the hope, dreams, and wishes you have for the future.

Reflect:

What are all the ways you can think of for upcycling waste materials in their home?

Compare and contrast how artists reuse words or images the way the way Scientists upcycle and reuse waste material.