Lesson: Shape of Wings

Grade Level: First Grade, Life Sciences

Overview: Students will learn about the Monarch Butterfly and their amazing wings. This species uses its wings to not only travel but as well as protect itself from predators. The bright orange and district black shapes on the wings are to warn predators not to “eat me”. These wings are actually poisonous to digest and even though they have a beautiful appearance, is a physical attribute to warn others. The most important key role of these wings are the natural engineering design for the ability to travel far. Given the ability to fly thousands of miles to migrate, the Monarch’s large and flexible wings give them a burst of propulsion. Students will learn how research scientists have discovered that these wings "clap" together, squeezing out the air between with such force that it thrusts them forward. Students will gain knowledge of these wings and create their own Monarch butterfly model. Students will design wings using shapes and color. Then students will take their designed wings and taped them onto a balloon. Students will model the “clapping” motion by pushing down on the top center of the balloon, between the wings. Students will observe their designed wings “clapping” back and forth, similar to the Monarch when flying. Finally, students will learn that humans have studied structures of animals to mimic similar movement in many man-made inventions such as cars, airplanes, and boats.

Science Content & standards:
Pennsylvania New Academic Standards for Science-
https://www.pdesas.org/Page/Viewer/ViewPage/11

Life Sciences: From Molecules to Organisms: Structures and Processes

Standard- 1-LS1-1: Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.

Science Practices:
APPENDIX F – Science and Engineering Practices in the NGSS
https://www.nextgenscience.org/sites/default/files/Appendix%20F%20%20Science%20and%20Engineering%20Practices%20in%20the%20NGSS%20-%20FINAL%20060513.pdf

Practice 6 Constructing Explanations and Designing Solutions

- Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
- Apply scientific ideas to solve design problems.
- Generate and compare multiple solutions to a problem based on how Constructing explanations and designing solutions.

Math Content & Standards:
Pennsylvania Academic Standards for Mathematics-
https://www.stateboard.education.pa.gov/Documents/Regulations%20and%20Statements/State%20Academic%20Standards/PA%20Core%20Math%20Standards.pdf

2.1 Numbers and Operations- (B) Numbers & Operations in Base Ten

Standard: CC.2.2.1.A.1- Represent and solve problems involving addition and subtraction within 20.

Standard: CC.2.1.1.B.1- Extend the counting sequence to read and write numerals to represent objects.

Math Practices:
Pennsylvania Common Core State Standards for Mathematical Practices.
https://static.pdesas.org/content/documents/Math_Practices_and_Grade_Progressions_rev%201-24-13.pdf

1. **Model with mathematics-** Experiment with representing problem situations in multiple ways including numbers, words (mathematical language), drawing pictures, using objects, making a chart, list, or graph, creating equations, etc.
2. **Look for and express regularity in repeated reasoning-** Look for patterns. For instance, they adopt mental math strategies based on patterns (making ten, fact families, doubles).

Science & Math Connection:
https://static.nsta.org/ngss/PracticesVennDiagram.pdf
Relationships and Convergences Found in the Common Core State Standards in Mathematics (practices), Common Core State Standards in ELA/Literacy*(student portraits), and A Framework for K-12 Science Education (science & engineering practices) *Venn Diagram NSTA Science, Math, & ELA-*

- S2. Develop and use models
- M4.Model with mathematics
- S5. Use mathematics & computational thinking

Materials:

- Balloons or small balls that can bounce.
- White cardstock
- Colored pencils or markers
- Scissors
- straws
- Masking tape
- **Option:** Chenille sticks and/or googly eyes for facial or other external structures.

Resources:

- Teacher resource articles:
    - PSU Hummingbird Flight article
    - *How butterflies fly?*https://wisconsinpollinators.com/BU/BA_ButterflyFlight.aspx
    - "The Girl who Drew Butterflies" by Joyce Sidman
- Teacher resource video, https://youtu.be/fBakLuH6kDY
- Student resource video, https://youtu.be/Wuo5WSyZG7U
- Student worksheet template- "Shape of Wings Template"
- Student resource reading passage- *"The Shape of Wings"*
- Extension reading, "The Girl who Drew Butterflies" by Joyce Sidman

Learning Objectives:

- Students will learn about Monarch butterflies and their aerodynamic wings.
- Students will design wings with similar shapes and patterns.
- Students will make a model of the Monarch butterfly.
- Students will use the Monarch butterfly model to observe the wings' movement.
- Students will learn how human-made vehicles have been designed with animal structure's in mind.

Lesson Procedure:

1. The teacher will read and discuss the reading passage, "The Shape of Wings", located in the google folder. The teacher can guide students into a classroom discussion based on the reading.
2. Students will watch the short video about Monarch butterflies, "On the Wings of a Monarch". The teacher can guide students into a classroom discussion based on the video.
3. The teacher will give each student a copy of the "Shape of Wings Template". The teacher will guide students in making a model Monarch butterfly. **(Follow instructions below, on page 3.)**
4. After completing the model, students will demonstrate the movement of "clapping" by using the model butterfly. Give students 5-10 minutes to explore the motion of the model.
5. **Option: to align this activity to math standards, the teacher can guide students in measuring the length of their completed butterfly's wingspan using a ruler. The teacher can also have students count the amount of claps they hear from the butterflies' wings.**
6. The teacher will guide students in a whole class discussion to review.
    a. How are Monarch butterflies able to fly hundreds of miles?
    b. Was your model able to clap? Did you have to re-design your model?
    c. Do you think other pollinators and/or animals have similar or different types of wings?

d. Do you think humans look at animals for inspiration to design vehicles? Can you give an example?

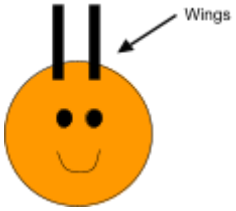
7. The teacher can extend the lesson by showing illustrations within the book, “The Girl Who Drew Butterflies” by Joyce Sidman. **(Note- this book is great as a teacher resource and for illustrations to show students different types of butterflies. Not to read a-loud.)**

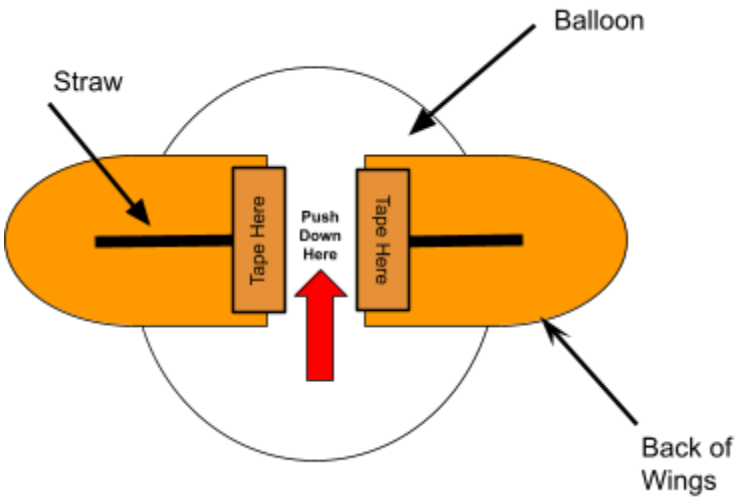
Directions- How to make Monarch Butterfly Model:

1. Print the “Shape of Wings Template” onto white cardstock.
2. Have students draw shapes and lines on the “Shape of Wings Template”.
3. Use scissors to cut out the wings.
4. Put wings aside and cut a straw in half.
5. Tape on both halves of the straw on the back of the butterfly wings.
6. Set wings aside, blow up balloons. **(Helpful tip: Make sure the balloon is bouncy, do not blow up the balloon all the way or balloons could pop.)**
7. Place and tape both wings on the top center of the balloon. **(Helpful tip: the wings need to be taped standing up straight on the balloon.The straw is there to act as support.)**
8. Option: draw, cut, and tape on external butterfly structures such as; (eyes, proboscis, antenna, etc.)
9. Press your finger on the center of the balloon, between the left and right wing. Push down and up and observe the wings “clapping” back and forth.

Model Set-up:

(Please be advised- the wings should be taped standing straight up. Place tape across the straw from left to right when placing the wings, shown on model example.)




Balloon
Straw
Tape Here
Push Down Here
Tape Here
Back of Wings

The Shape of Wings

investigating the wings of the monarch butterfly

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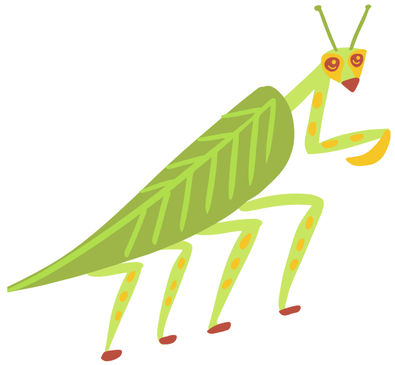
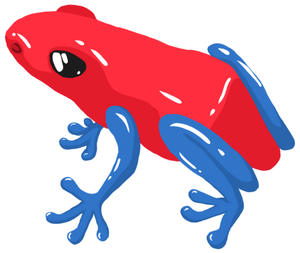
The monarch butterfly may be the most famous orange-colored creature in the animal kingdom. Its color, while beautiful, is also very important because it helps the monarch to survive. **How does color help animals to survive?**

Camouflage
"You can't see me!



Mimicry
"I'm a leaf!"



Warning
"I'm dangerous!"

How do you think the color orange protects monarch butterflies from predators? Here's a hint: their main predators are birds.

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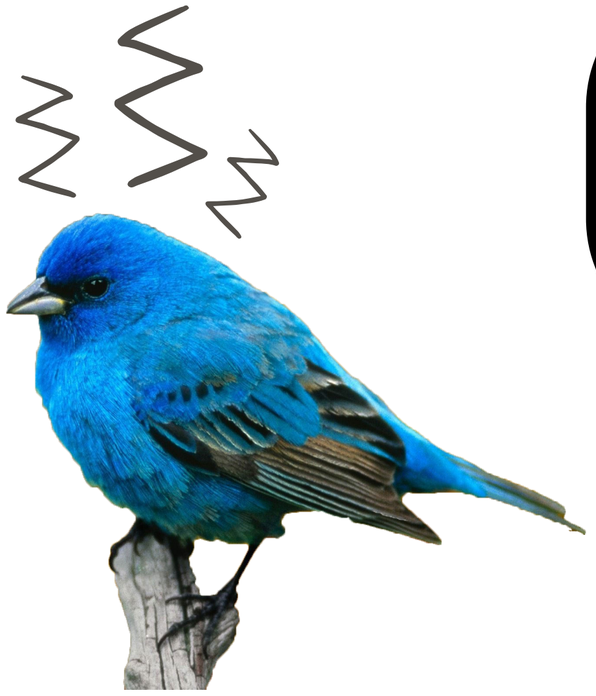
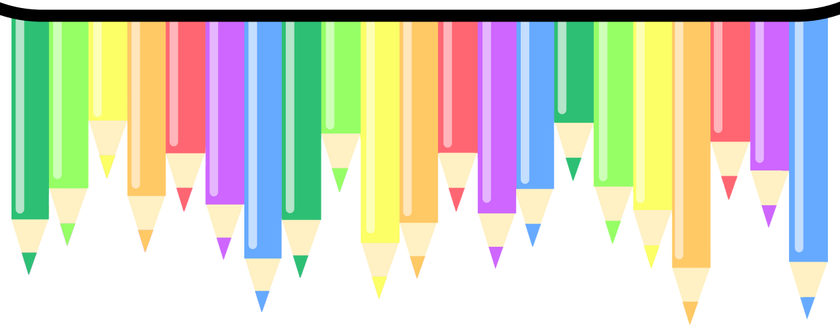
Monarchs use their orange color as a **warning** to say "Don't eat me, I will make you sick!". This warning is a truthful signal- monarch butterflies are toxic and cause animals that eat them to be sick!

Scientists have found birds that eat a monarch once will never eat a monarch again, because they remember how sick they felt before. They won't be making that mistake again!



Think about it...

What do different colors remind you of?

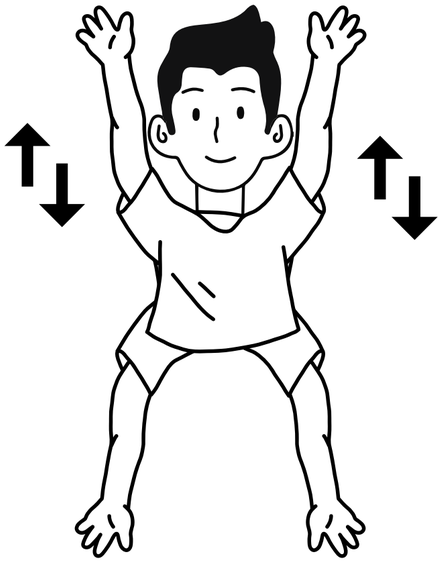


A monarch's wings not only protect them from predators, but they also take them places. Each day monarchs fly from flower to flower, eating nectar.

Twice a year monarch butterflies embark on a great migration, flying hundreds of miles between the U.S. and Canada to Mexico and back. They make this journey in just weeks. Could you run to Mexico that fast?

So, how do monarchs do it?

The shape and function of the monarch's wings help it make the long migration. First, how do wings work? They flap up and down. Practice with your arms! Can you feel the air on your hands as you flap?



When the monarch's wings go up, the air in between its wings is squeezed out with such force that it thrusts the butterfly forward. The butterfly is able to fly farther while using less energy!

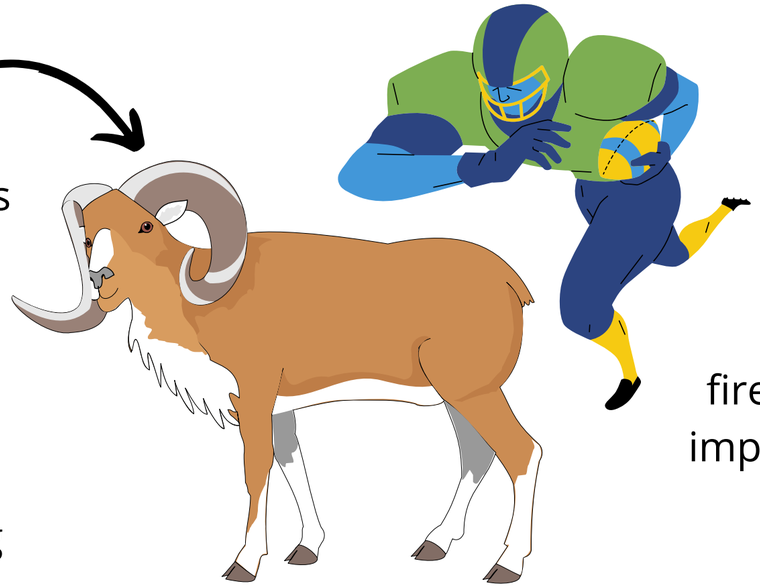
Fun Fact!
The Peregrine Falcon, the world's fastest bird, inspired the design of the swift B2 bomber!

Engineers have always been inspired by the amazing skills that animals have...

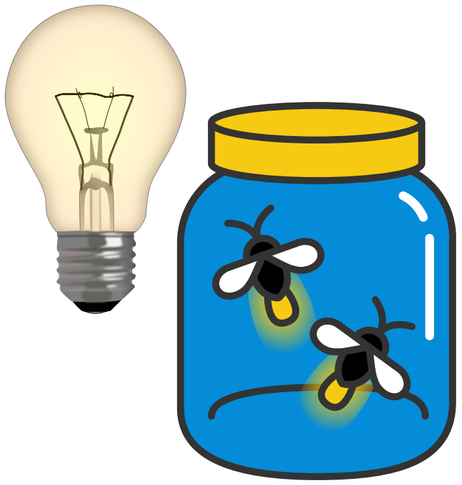
Researchers at MIT were inspired by sea otters to create a wetsuit that functions like their fur. The suit keeps the wearer warm by trapping air bubbles. [1]

A team from Stanford University found that hummingbirds are more efficient at hovering than helicopters. As technology improves, we will surely look to the hummingbird for inspiration. [2]

Male big horned sheep intentionally hit their heads together, withstanding impacts that are 10 times greater than two football players. The Cincinnati Children's Hospital Medical Center is experimenting with safety equipment inspired by the big horned sheep. [3]



Penn State University is creating LEDs made with firefly-mimicking structures, improving the efficiency and sustainability of the light source. [4]



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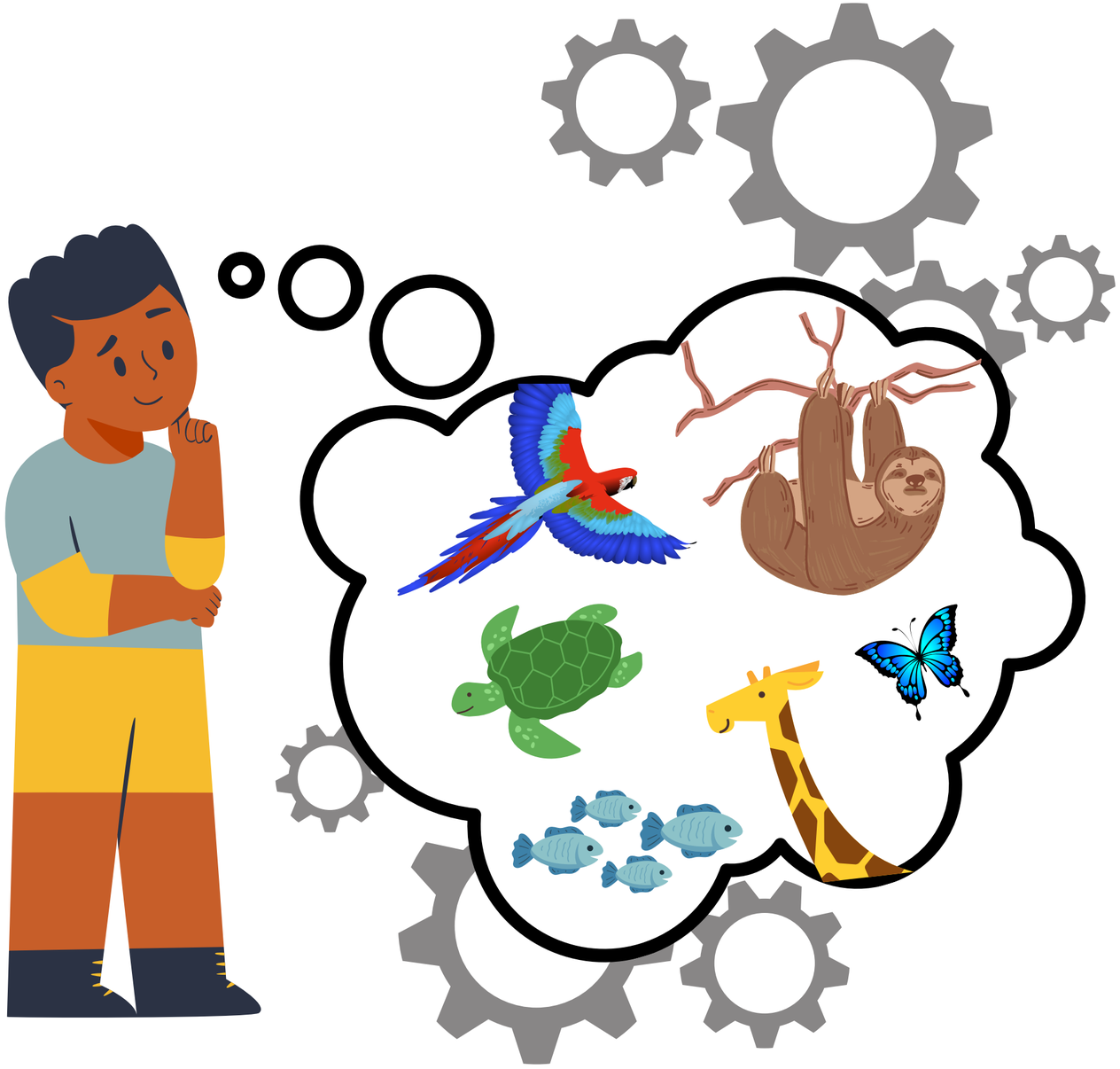
What animals will inspire **you** to create the next great invention?



[1] Nasto, A., Regli, M., Brun, P.-T., Alvarado, J., Clanet, C., & Hosoi, A. E. (2016). Air entrainment in hairy surfaces. Physical Review Fluids, 1(3).

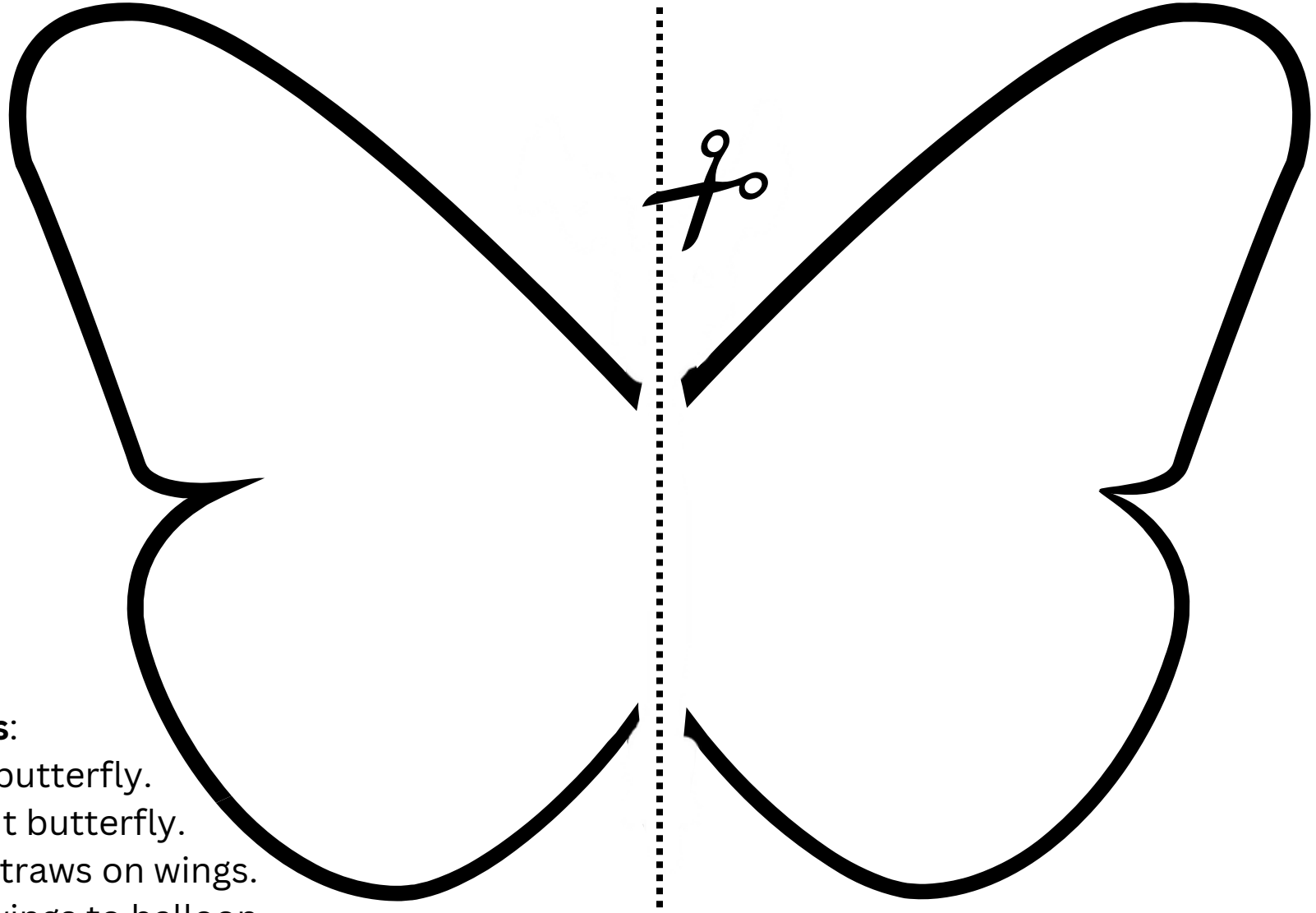
[2] Kruyt, J. W., Quicazán-Rubio, E. M., van Heijst, G. J. F., Altshuler, D. L., & Lentink, D. (2014). Hummingbird wing efficacy depends on aspect ratio and compares with helicopter rotors. Journal of The Royal Society Interface, 11(99), 20140585.

[3] Cincinnati Children's Hospital Medical Center. (2016, June 15). Research shows promising results for a device designed to protect athletes from sports-related brain injuries: Experimental neck collar inspired by woodpeckers and bighorn sheep. ScienceDaily.

[4]Shizhuo Yin, Chang Jiang C, Wenbin Zhu, Ju-Hung Chao and Annan Shang, 2019, "Ultrahigh light extraction efficiency light emitting diodes by harnessing asymmetric obtuse angle microstructured surfaces", Optik, 182, pp. 400

Front

Monarch Butterfly Wing Template



Directions:

1. Color butterfly.
2. Cut out butterfly.
3. Tape straws on wings.
4. Tape wings to balloon.

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Monarch Butterfly Wing Template