



Flying Butterfly

(This lesson utilizes an adaptation of the Climbing Butterfly activity from Arvind Gupta's Toys from Trash:
<https://www.arvindguptatoys.com/toys.html>)

Materials

Butterfly Templates (last page of this document)
Tape (transparent or masking)
Double Stick Tape or Glue
Bakers Twine or similar string

Large Craft Sticks (also known as tongue depressors)
Plastic Drinking Straws
Markers or Crayons or Colored Pencils
Pushpins
Scissors

Key Question

How do friction and gravity help the Flying Butterfly toy work?

Learning Objectives

Young scientists will...

- make and play with the Flying Butterfly toy.
- notice and wonder about how friction and gravity are helping their toy work.

Vocabulary (See **What the heck? Explanation of Science** at the end for definitions.)

Gravity

Friction

Mass

Tension

SAFETY CONCERNS

- None

STEMAZing Teaching Philosophy

Children should always be given ample time to experiment, notice, and wonder before they are provided an explanation.

Always engage children with our two favorite questions:

What do you notice? What do you wonder?

Resist the urge to answer any questions children have while exploring. Instead, respond back with questions to children and let them make sense of the world. Sample questions you might use: What do you think? Do you notice any patterns? What could we change? Can we test something else? What can we try next? If children ask a testable question, which they could answer by doing an experiment, talk through with them how they might design a test to help answer their question. As much as possible and within reason, let them actually test their questions by trying the experiments they propose.

Advanced Teacher Preparation

Print out the butterfly templates on white cardstock.



Figure 4

Building the Flying Butterfly Toy

1. Cut out and have young scientists color the butterfly templates. Each scientist will need two identical templates. You can discuss symmetry in butterflies – how each half of the butterfly matches the other side. They can color the front different from the back butterfly pattern. You can show them how butterfly wings can be different on the inside versus the outside. This could also be an opportunity to talk about camouflage.
2. Once scientists have colored their butterfly templates, they should flip one template over and tape two straw lengths to it, as shown in Figure 1. Note how the straw lengths are not parallel but rather the top of the straws are tilted in a bit and the bottoms are angled out.
3. Using either double stick tape or glue, stick the two butterfly templates together with the straws in between them.
4. For each toy, cut two strings about 1 meter long. Tie these to the outside ends of the large craft stick. Also, tie a loop in the middle of the craft stick. (See Figure 2.) Once these are tied in place, use tape to secure them.
5. Now, thread the ends of the long strings through each of the straws going through the butterfly. Put a piece of tape folded over on itself on the end of each string to keep it from pulling back through the straws, as shown in Figure 3.
6. Now, use a pushpin to secure the toy to a wall, as shown in Figure 4.



Figure 1

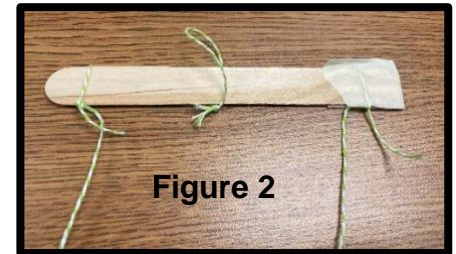


Figure 2

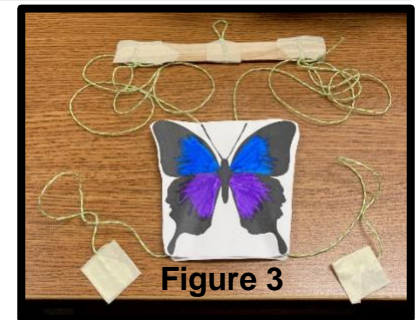


Figure 3

Notice and Wonder Developmentally Appropriate Practice

1. Challenge young scientists to get the butterfly to fly up the strings to the top. Let them explore and play with the toy before you give away the secret strategy.
2. After a bit of time, show scientists how to make the butterfly fly. They might naturally have tried to spread the strings apart at the bottom to get the butterfly to fly up. The secret strategy though is to keep just the right tension on the strings while they hold them parallel pulling first one down and then the other. The craft stick will wobble back and forth and the butterfly will climb up the strings.
3. Then demonstrate how the butterfly is pulled back down by gravity when they let the tension out of the strings. Encourage young scientists to shout out “Gravity!” when they are letting the butterfly drop back down to the ends of the strings.
4. Let them play, notice, and wonder! Have them share their best strategies for getting the butterfly to fly the highest or fly up the fastest.



Young scientists should notice...

- they can make the Flying Butterfly “fly” up the string a couple of different ways – by pulling the strings apart at the bottom and by pulling the strings straight down one side and then the other.
- the Flying Butterfly will fall back down to the ends of the strings when the tension is released and gravity takes over.
- the Flying Butterfly can move up the string faster or slower depending on how quickly they pull the strings down on one side and then the other.

Differentiating Developmentally Appropriate Practice

Older students should be able to color and construct the Flying Butterfly on their own. They may also think of more advanced things to test using the toy.

Younger students may need more support from the teacher when building and assembling the Flying Butterfly. They should have no trouble at all playing with them once they are assembled.

Extensions for Additional Learning

As always, ask the children throughout the experiment what they notice and what they wonder. If their wonder questions are testable, as much as possible and within reason, let them actually test their questions by trying new experiments.

See below for examples of what they might wonder and experiments they might do to test their wonderings.

- I wonder what would happen if I build a Flying Butterfly with the straws tilted outward at the top instead of inward?
 - Let them try it! They can determine if this design works better or worse than the original design.
- I wonder how big I could make the Flying Butterfly and if it would still fly up if it were much bigger?
 - Let them try it! Let them make a butterfly that is much larger and see if it will still fly up the strings.

#STEMAZingPictureBook Recommendations:

Baby Loves Gravity! by Ruth Spiro (author) and Irene Chan (illustrator)

- Learn more about gravity, how and why it affects different objects, and how babies like to test gravity.

How to Hide a Butterfly & Other Insects by Ruth Heller (Author and Illustrator) – great to use if you are going to incorporate camouflage into the lesson.

AZ Early Learning Standards

Above and beyond the Social Emotional, Approaches to Learning, Language and Literacy, Social Studies, and Physical Development, Health, & Safety Standards which may naturally apply to the lesson, the following Science, Math, and Fine Arts Standards are strongly connected to this lesson:

Science Standard – Strand 1: Inquiry & Application

Concept 1: Exploration, Observation & Hypotheses – The child observes, explore, and interacts with materials, others, and the environment.

Concept 2: Investigation – The child researches their own predictions and the ideas of others through active exploration and experimentation.

Flying Butterfly – What the heck?

Explanation of the Science (Vocabulary in bold.)

The Flying Butterfly works because applying a little bit of **tension** (a force applied to a string, cable, or rubber band) and holding the bottom of the strings out, creates friction between the straws and the strings running through them. **Friction** is a force created when two objects try to slide past each other or are sliding past each other. The friction created on one side between the straw and the string is enough to hold the butterfly in place while the other string slides through the straw as it is pulled down. This is because static friction felt between two objects trying to slide past each other but not yet moving is more than kinetic friction felt between two objects (the straw and string) when they are sliding past each other. When one of the strings is pulled down the other one stays in place while moving up allowing the butterfly to fly up a small distance. Then, when the opposite string is pulled down, static friction once again holds the other string in place (pulling the butterfly up with it) while the string being pulled down moves through the straw (thanks to kinetic friction being smaller than static friction). When repeated, this back-and-forth action of one side sticking and the other sliding causes the butterfly to fly up the strings.

When the butterfly is at the top and the tension in the strings is released, the friction is greatly reduced and gravity pulls the butterfly back down toward Earth. **Gravity** is an attraction between objects that have mass. **Mass** is a measure of the amount of matter that makes up all objects. All things on Earth's surface are affected by Earth's gravity because Earth has a huge mass. This means Earth will pull things back down toward its surface when they are lifted away from it, unless there is some other forces acting on the object to keep it elevated. Once gravity pulls the butterfly down, then you can use friction to make it fly again!

