WITH YOU WHEN YOU FLY:

Aeronautics for Pre-K

Teach science and literacy through stories.

6 integrated science lessons based on 6 popular children's books

Literature List

Lesson 1: Gliders in Nature – Key Concepts: Form and Function

The Dandelion Seed
Text copyright © 1997 by Joseph Anthony
Illustrations copyright © 1997 by Cris Arbo
Dawn Publications

Lesson 2: Balloons – Key Concepts: Floating and Sinking, Weight

Hot Air: The (Mostly) True Story of the First Hot Air Balloon Ride
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Atheneum Books for Young Readers,
An imprint of Simon & Schuster Children's Publishing Division

Lesson 3: Parachutes – Key Concepts: Fluid Thickness, Drag

Egg Drop
Copyright © 2009 by Mini Grey
Knopf Books for Young Readers

Lesson 4: Kites – Key Concepts: Area, Lift

Kite Festival
Copyright © 2004 by Leyla Torres
Farrar, Straus, and Giroux

Lesson 5: Airplanes and Helicopters – Key Concepts: Force, Propulsion

Clorinda Takes Flight
Text copyright © 2007 by Robert Kinerk
Illustrations copyright © 2007 by Steven Kellog
Paula Wiseman Books/Simon & Schuster Books For Young Readers,
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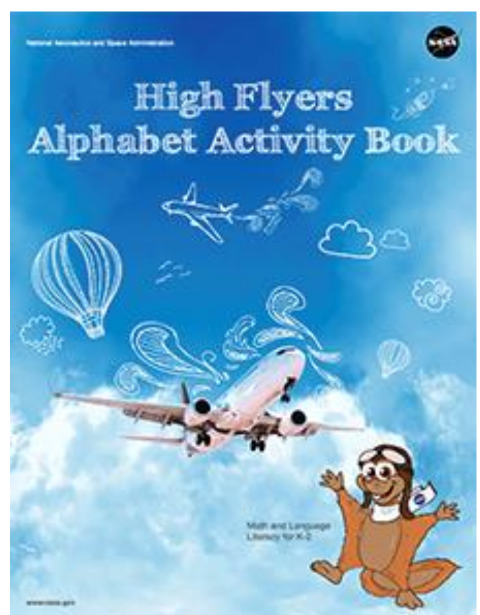

Lesson 6: Global Flyers – Key Concepts: Geography, Interconnectedness

Planes Fly!
Text copyright © 2013 by George Ella Lyon
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An imprint of Simon & Schuster Children's Publishing Division

With You When You Fly
NASA's Educator Resource Guide to *Living in the Age of Airplanes*
http://www.nasa.gov/sites/default/files/files/Living-in-the-age-of-airplanes-resource-guide.pdf

Supplement your science of flight lessons with NASA's High Flyer's Alphabet Activity Book: http://goo.gl/GmWEml

- Writing
- Reading
- Math
- Colors/Shapes

Overview

Aeronautics for Pre-K: A Literacy Approach for Science

Although most children (and adults) associate NASA with space flight, NASA's first "A" stands for "Aeronautics."

Before the first airplane, scientists and engineers worked to develop lighter-than-air aircraft using the principle of buoyancy. They also turned to parachutes and gliders to learn to drift across air currents and slow their rate of descent as they fell. It is from these early beginnings that aviation and space flight have become what they are today. In this full unit of study for pre-school and early elementary students, we will investigate gliders in nature; balloons, parachutes and kites; helicopters and airplanes; the impacts of aviation through classic children's literature; and science and engineering activities.

This educators' guide provides an opportunity to teach thematic lessons on aeronautical science principles through children's literature. The guide is the result of an effort to address a growing need for early STEM education, and is founded on the ideas and principles provided by popular children's books.

Because a robust instructional approach is also very important, these activities are aligned with the cross-cutting principles and science and engineering process skills elaborated in the Next Generation Science Standards. Many can also be easily applied or adapted to teach the Next Generation Science Standards and the Common Core State Standards for early elementary education.

Table of Contents

Early Learning Standards for Scientific Inquiry and Physical Science

This document was created with the National Science Teachers Association (NSTA) Position Statement: Early Childhood Science Education in mind. To access the full document, please visit: http://www.nsta.org/about/positions/earlychildhood.aspx The NSTA position statement emphasizes that even very young children are capable of learning fundamental scientific concepts and practices. The primary approach to teaching science should encourage inquiry, hands-on activities, and play.

Many of the scientific investigations in this guide can also support Common Core State Standards English language arts and math literacy that children need to develop throughout their school years: http://www.corestandards.org/

Through the activities in this guide, children learn about fundamental physical concepts, as well as become introduced to many of the science and engineering practices listed in the Next Generation Science Standards: http://www.nextgenscience.org/

Lesson 1

Gliders in Nature

Lesson 1: Gliders in Nature

Birds fly, and so do some small mammals. However, a much larger number of organisms, including plant seeds, glide. In this module, children will first compare common seeds that glide, and determine what physical characteristics make them good gliders, as well as why gliding is advantageous. Children will then be read *The Dandelion Seed* to categorize seeds within the book as gliders or non-gliders based upon their physical characteristics. These concepts help prepare young students to understand form and function. By learning about the characteristics of a good glider, children will also learn how humans have long attempted to fly by copying ideas from nature, often referred to as biomimicry.

Focus Storybook

The Dandelion Seed
By Joseph Anthony, illustrated by Cris Arbo
Copyright © 1997 by Joseph Anthony and Cris Arbo
Used with permissions of the author and illustrator
Dawn Publications

Learning Goals

Language	• Vocabulary: Fly, Glide. • Writing: Write “F” and “G.”
Math	• Count the twists as a paper “seed” glides down. • Measure distance of a blown seed (near/far).
Science/ Engineering	• Explain what characteristics make for a good glider, and why gliding is important (biology). • Design a seed that takes the longest time to fall (physics).

Key Q’s

What kinds of things fly or glide? What makes them able to fly or glide? Why is it good to be able to fly or glide?

Primary Materials

Images of animals and plant seeds that fly/ glide.
Maple seeds (fresh or dry, enough for each student to have 2-3).
Seed samples – multiple examples of seeds that glide (maple, elm, dandelion, milkweed, etc.) and seeds that don’t (coconut, acorns, hitchhikers, seeds found in fleshy fruits, etc.)
Whirly-bird template
Paper Clips
Scissors
Crepe/streamers

Resources

High Flyers e-Book

Fine Motor Skills	• Cut a straight line.

Science/Engineering: Pre-Reading Activities

Investigation: Flyers and Gliders in Nature

Perhaps one of the best examples of the intersection between biology and engineering to which small children can relate is the study of flight. Children's books often focus on topics such as plants and animals and things that "go" (i.e. cars, trucks, and planes), but the relationship between these topics is often overlooked.

1. Begin a discussion of flight by helping students to *i*dentify some flyers in nature. Children will most likely think of:

- Birds
- Insects (butterflies, bees, etc.)
- Bats

However, not all things that travel by air actually fly. Generally, *flyers* power their own motion (typically by flapping), while *gliders* simply let themselves be carried by the wind. Gliders include a variety of seeds that get dispersed by the wind, baby spiders that "balloon" away from their place of birth, and many fish, mollusks, amphibians, and mammals that use gliding to stay aloft when jumping, or to slow themselves down as they fall.

2. Provide students with books and printed/projected images of animals that fly or glide, and those that do not (see the following pages for images).

3. Discuss how flyers and gliders look.

- They have wings (flyers/gliders), or extra skin that acts as a parachute (gliders).
- They have big wings for their size.
- They have thin (aerodynamic) bodies.

4. Discuss why it might be beneficial to animals and plants to be able to fly or glide.

- It is faster than walking.
- It is easier to get away from danger.
- It is easier to cross forests/rivers/oceans/mountains, etc.
- It allows animals to have access to a much larger area for food and shelter.
- It allows plant seeds to get spread over a much larger area so that they have a better chance of survival and reproduction.

Birds that Fly/Glide

Bald Eagle, Photo Credit: USFWS

Mallard Duck, Photo Credit: USFWS

Birds that DO NOT Glide

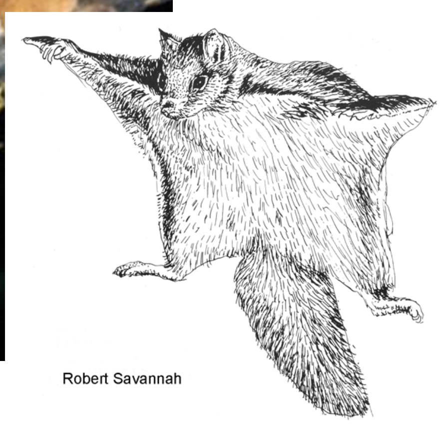
Penguins, Photo Credit: NSF

Attwater's Prairie Chicken, Photo Credit: USFWS

Other Gliding Animals

Mexican Long-Tongued Bat, Photo Credit: USFWS

Flying Fish, Photo Credit: NOAA



West Virginia Northern Flying Squirrel, Photos Credits: USFWS

Some examples of flyers and gliders include:

- Birds (most) - FLYING
- Mammals (some)
    - Gliding squirrel (as can be seen in NASA Aeronautics' mascot!) – GLIDING
    - Possums – GLIDING
    - Lemurs - GLIDING
    - Bats - FLYING
- Amphibians (some) – Flying frog – GLIDING
- Reptiles (some)
    - Lizards – GLIDING
    - Geckos – GLIDING
- Fish (some) – Flying fish - GLIDING
- Mollusks (some) – Flying squid - GLIDING
- Arthropods (most)
    - Insects – FLYING
    - Spiders – BALLOONING
- Pterosaurs (extinct) – FLYING

Although birds are often the first thing children think about when asked what kinds of animals fly, not all birds are capable of flying or gliding. After discussing what makes an animal a good glider, ask students to look at a variety of images of birds that can and can't fly, to see if they all have the traits necessary for gliding. Consider looking at the following:

- Birds – Look at bird feathers or images of different types. See some examples you might want to discuss below:
    - Which kinds of birds glide?
        - Eagle – YES
        - Chicken – NO
        - Duck – YES
        - Ostrich – NO
        - Penguin - NO
    - What is the difference between birds that glide/fly and birds that don't?
        - Gliders typically have streamlined bodies and large wings for their weight. These birds tend to need to fly long distances without stopping (migratory birds, sea birds).
        - Non-gliders do not necessarily have streamlined bodies or large wings. These birds are often land-bound, and are able to eat their prey and protect themselves without the need for flight.

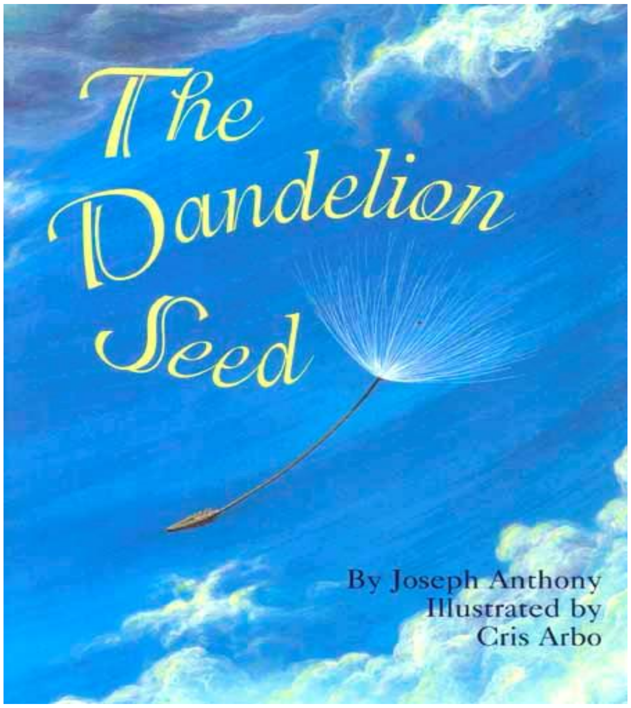
Color Orville the Flying Squirrel, NASA Aeronautics' new mascot!

Like most other squirrels, flying squirrels live high up in the treetops. What is the benefit of having the extra skin between a flying squirrel's arms and legs?

Although they are called flying squirrels, do flying squirrels actually fly? Explain!

For a long time, people tried to FLY by making machines or outfits that they hoped people would be able to use to flap. However, gliding is much easier than powered flying. The first people to really be successful at building airplanes first made sure that they understood how to GLIDE before they tried to FLY.

Although gliding and flying are what people have long wanted to do simply because they are fascinated by both, there is a really important reason for flight – because of travel! In the same way, plant species are most successful at surviving if they can spread their seeds all over, using the wind to disperse.



Reading: The Dandelion Seed

By Joseph Anthony, illustrated by Cris Arbo

Dawn Publications

Read *The Dandelion Seed*, a book about the lifecycle of dandelions, from seed to flower to seed. The focus is on the journey the seed can make because of the force of the wind and the tufts that make it glide across the land. As you read, consider using the following strategies to engage the listeners:

- Why would a dandelion plant want its seeds to be carried by the wind?
- What makes a dandelion seed really good at being "caught" by the wind and being blown about?
    - It is very light
    - It has "feather-like" designs
- What would happen to the seed if the weather was bad? *(It might get blown really far away, or it might get wet and not fly at all).*

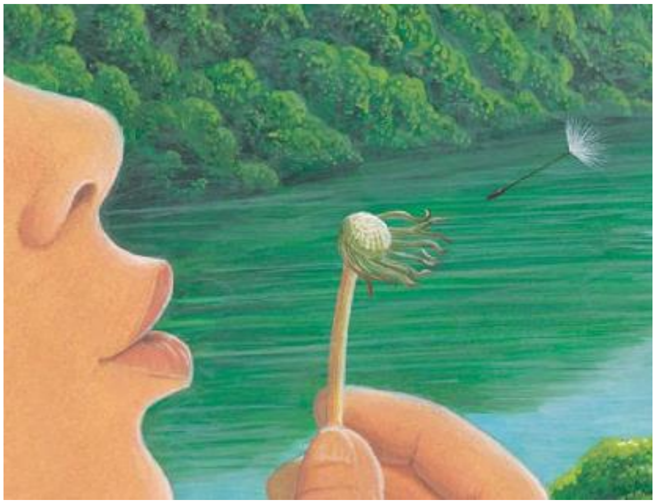


Figure 1: The Dandelion Seed, page 32

- What other seeds can be found in the pictures in the book? *Have students find at least three other seeds!*

Figure 3: The Dandelion Seed, pg. 12

Figure 2: The Dandelion Seed, pg. 5

- Are the other seeds found in the pictures in the book gliders, or are they not gliders? How do you know?
  Figure 2: These are examples of plants that dry up before releasing their seeds. The seed capsules either burst and release the seeds, or the seeds simply drop. These seeds ARE NOT gliders.
  Figure 3: These grass seeds have "feather-like" ends, much like the dandelion seeds. These seeds ARE gliders!
  Figure 4: Acorns are fairly heavy, and the wind cannot blow these seeds around. This seed IS NOT a glider.

Figure 4: The Dandelion Seed, pg. 20

- Dandelion seeds glide really well. Do airplanes look like dandelion seeds? What is similar? What is different? *(Remind students that airplanes FLY with engines or propellers that can take them where they want to go, and that they only sometimes GLIDE. A gliding seed gets pushed around wherever the wind takes it).*

- What happens to gliding seeds when the weather gets bad? How do you think weather affects airplane flight? *(Because airplanes don't want to get pushed around – they might end up in the wrong place – airplanes usually won't fly in really bad weather).*

Science/Engineering: Book-Based Activities

Discovery Learning: Seed Classification

Look at a collection of seeds of different types. Maple seeds, milkweed seeds, and dandelion seeds are some common gliding seeds found in North America. Ask students to classify the seeds as “gliders” or “not gliders,” and to explain how they classified them as they did.

See some more examples that you might want to bring into the classroom below:

Seeds that Glide

milkweed*

American elm*

green ash*

linden/beech*

maple*

Typically, gliding seeds have wings or fuzz that help them to get captured and carried by the wind. Coconuts float, and therefore are spread by water, while hitchhikers have hooks that can allow them to get picked up by passing animals. Seeds surrounded by fruit (such as apples, grapes, tomatoes, etc.) tend to get eaten by animals, and are then deposited by animals at another location after passing through their digestive system.

** Samples courtesy of U.S. Botanic Gardens.*

Seeds that DO NOT Glide

coconut

“hitchikers” / burrs

Interactive Demonstration: Maple Seeds

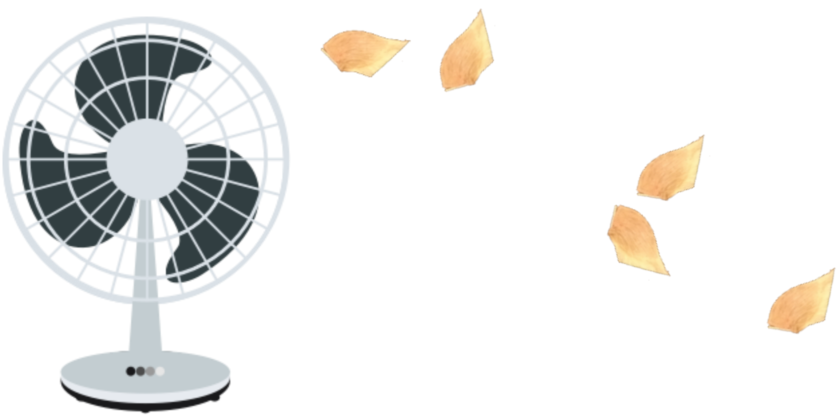
Look at maple seeds, and observe them glide to the ground by spinning. Discuss what benefits this might have to the seeds. *(The wind is more able to catch them and take them flying away from the base of the tree, so they spread out as much as possible, and so they can get their own sunlight as they grow).*

Inquiry Experiment: Wind and Wings

Maple seeds have a “wing” that behaves very much like an airplane or helicopter wing. Have students determine the effect of wind on maple seeds that have wings and those that do not. Prepare sets of maple seeds with and without wings.

Set up the classroom so that you place a large fan near ground level, so that children can drop maple seeds above the flow of the air. Give each child at least one maple seed (ensure that seed pairs are separated). Ask students to watch how the wind pushes the seeds all around.

Next, have students perform the same activity, but before dropping the maple seed, ask students to break off the wing from the seed capsule. This time, ask students to compare how far the seed capsule fell in comparison to the seed with the wing.



Children should find that by having the wing, the seeds are much more spread out by the wind.

Inquiry Experiment: Paper Whirly-Birds

Make a model "maple seed" glider or whirly-bird. This glider, also known as a whirly-gig, gets slowed down by its wings, much like a parachute, and spins as it falls.

The more times a "maple seed" spins, the more it is slowed down, and, therefore, the longer it can stay airborne! The goal of this activity is to find out what kinds of factors influence the number of spins made by the "maple seed."

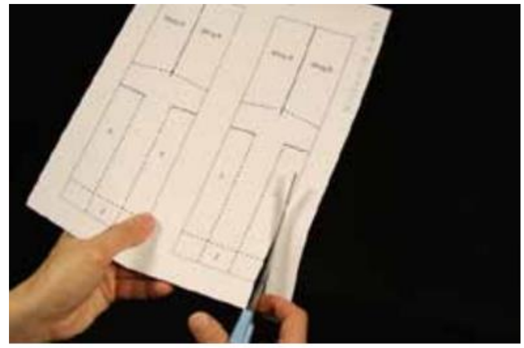
Experiment with the whirly-bird by investigating how weight, wing shape/width/length, etc. influences the time of fall or number of total spins that it makes. See NASA's Museum in a Box First Flyer Activity for more information:

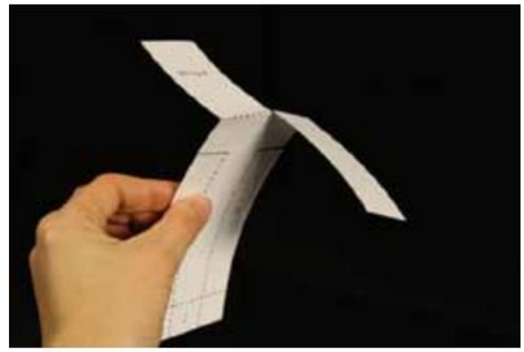
http://www.aeronautics.nasa.gov/pdf/first_flyers_k_4.pdf

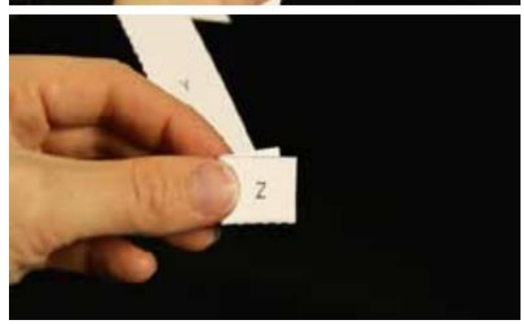
Use the attached template to allow students to practice cutting straight lines. (Consider cutting out the template for each child).

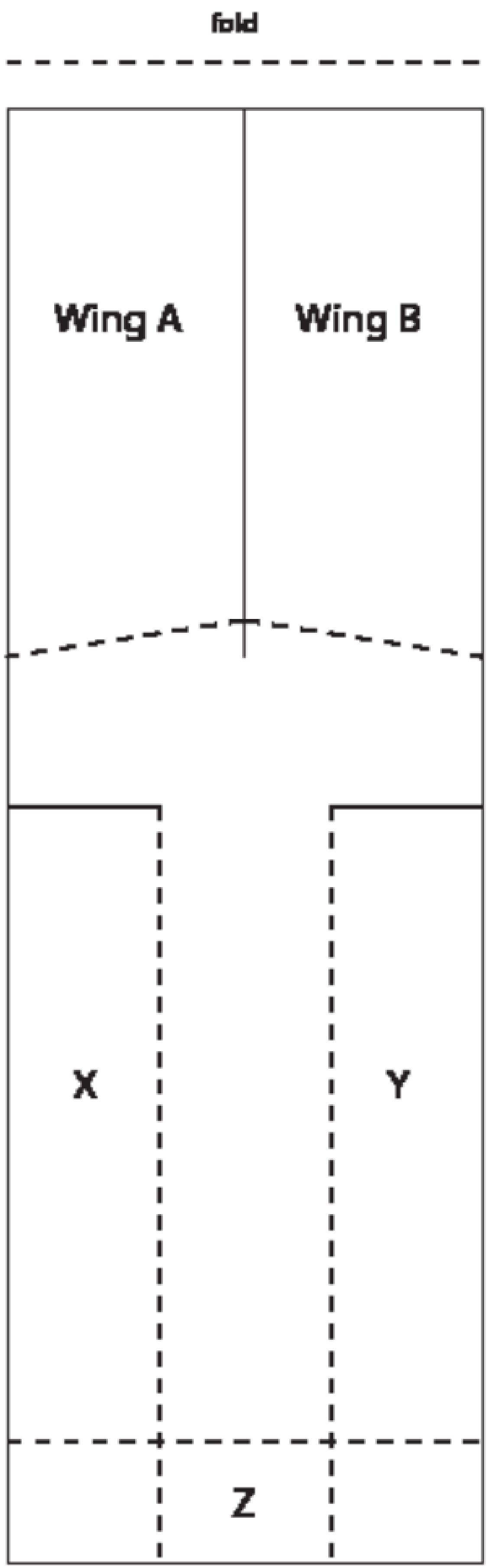
Allow students to cut the two horizontal slits as well as the vertical slit to separate wing A and wing B. (Consider providing children with a cut-out rectangular template, and simply highlighting the lines that they should cut.)

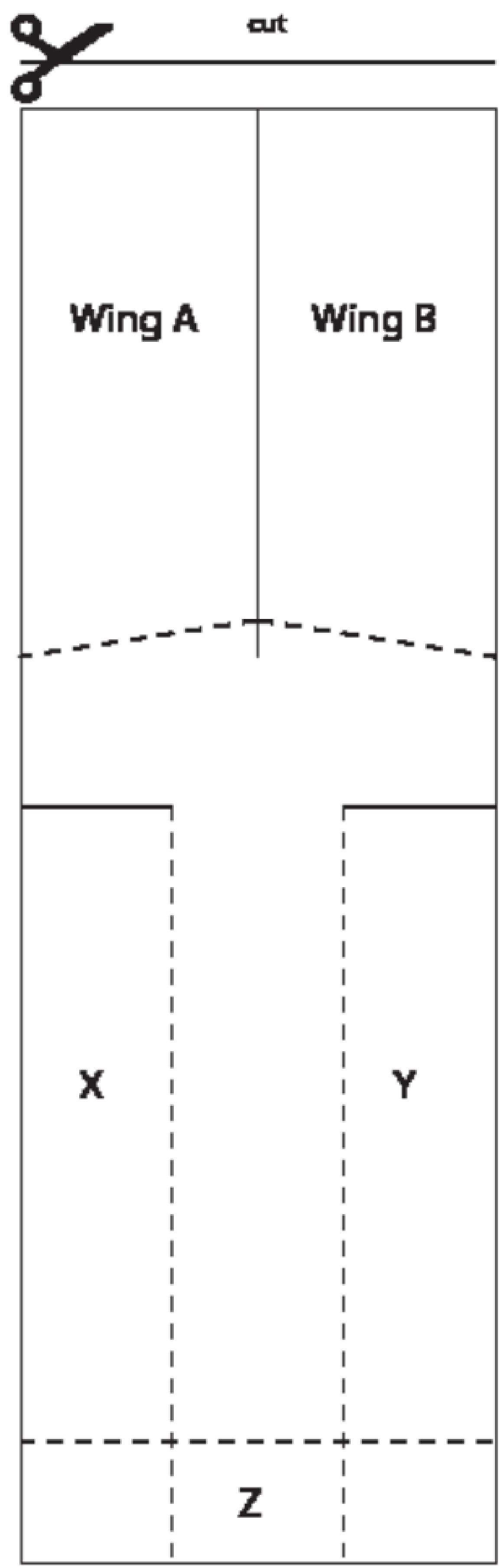
Assist children with bending the propellers and folding in the base. If necessary, attach a paper clip to the bottom of the propeller's body to give it some weight and to keep it folded.








fold
Wing A
Wing B
X
Y
Z

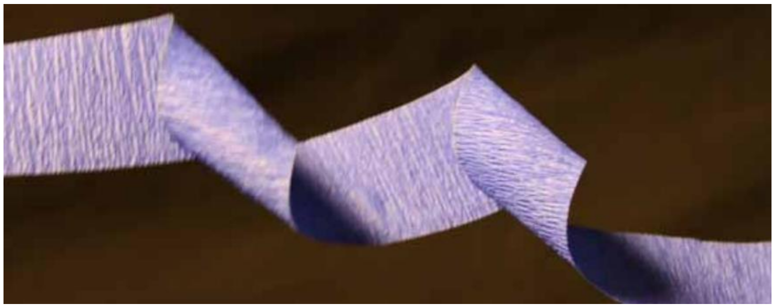

cut
Wing A
Wing B
X
Y
Z

Allow children to practice dropping the paper whirling "seeds."

Children can try to make their seeds take the longest time to fall. Variables that can be changed could include:

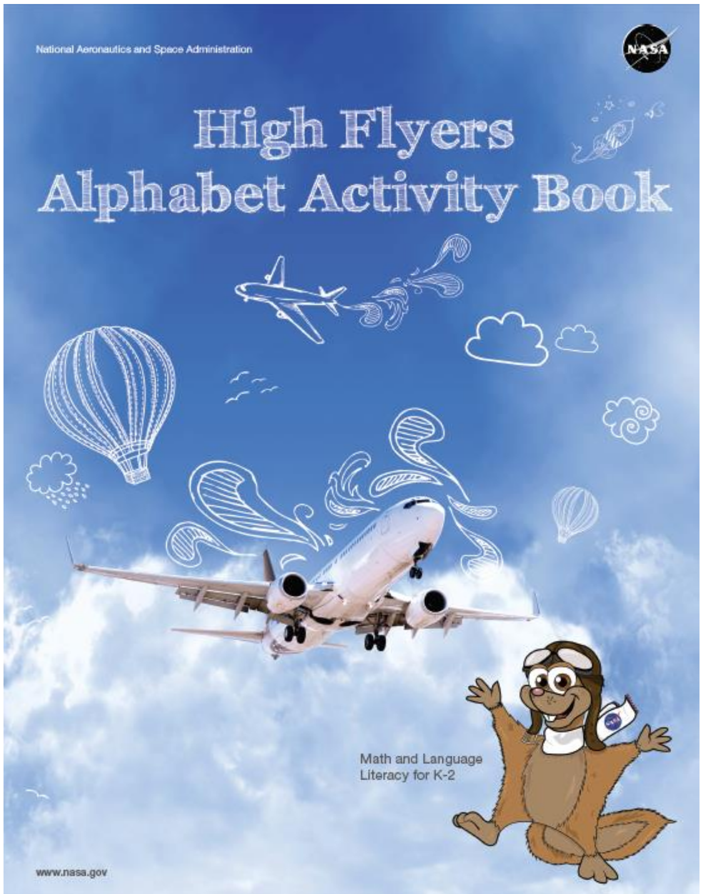
- Adding weight to the base of the seed (by adding paper clips)
- Changing the shape or length of the propellers (folding or cutting them)
- Removing one of the propellers (cutting it off)

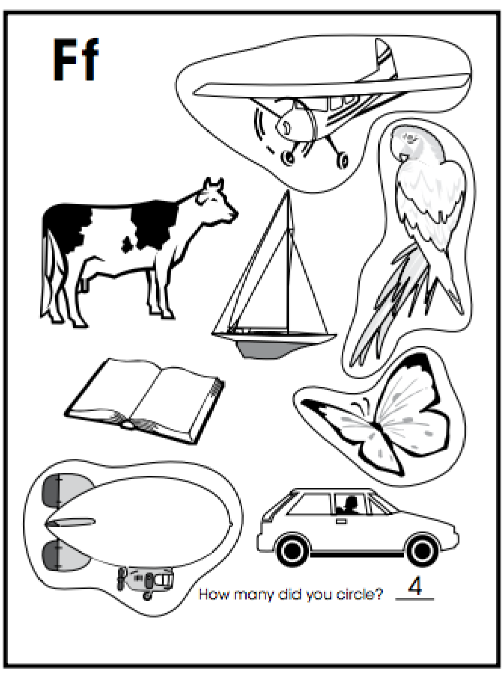
Children could also look for the relationship between variables and the number of twists made by the seed. (Adults should do the dropping, as children are likely too small). To determine the number of twists, attach a piece of crepe (streamer) paper to the bottom of the seed with a piece of tape. The adult should place his/her foot on the flat streamer, then allow the seed to fall. The twists can then be counted by children as they are untwisted.

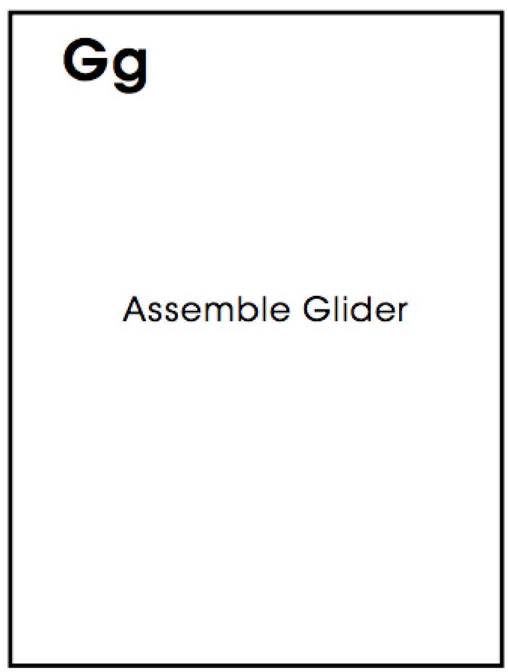


Writing: “F” and “G”

Practice writing the letters F and G. Use NASA’s High Flyers Alphabet Activity Book.



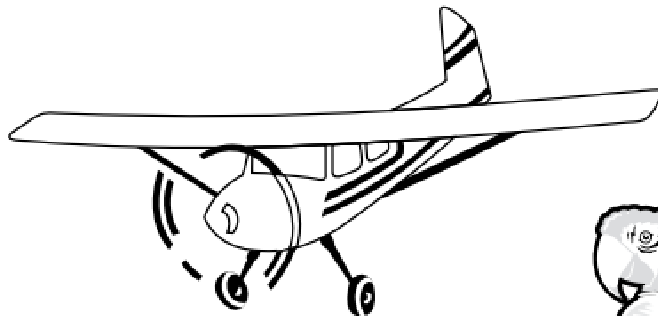


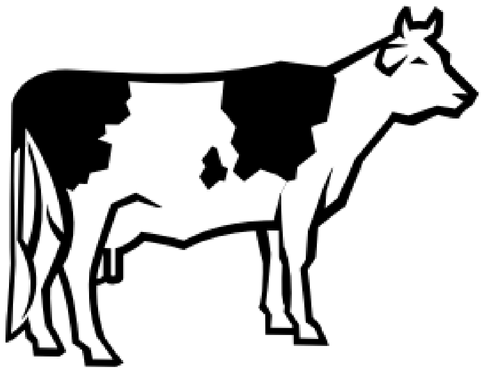


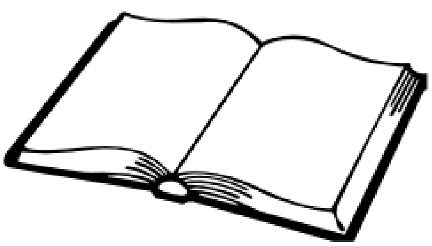
Ff

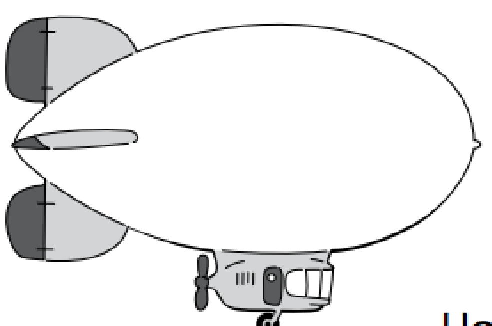
fly

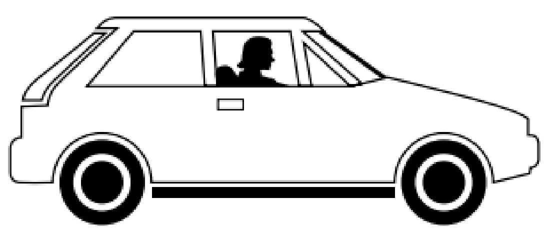
Circle the pictures
of the things that fly.











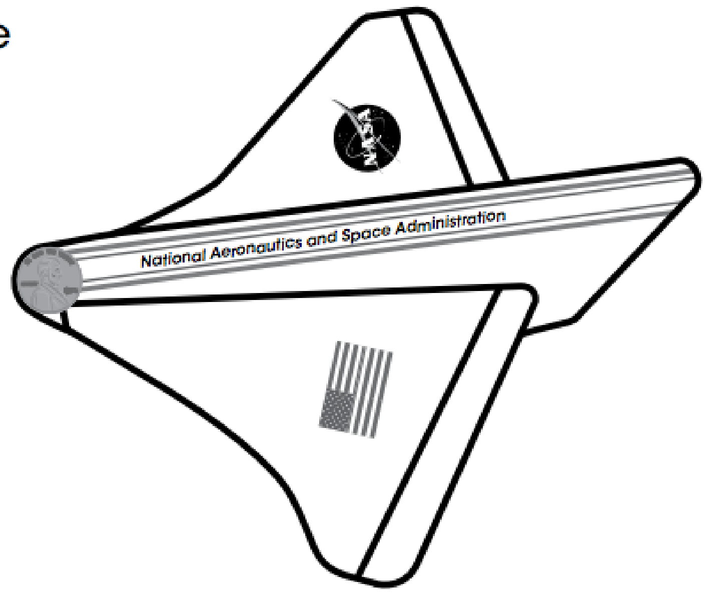
How many did you circle? _____

Gg Gg

glider

Materials Needed

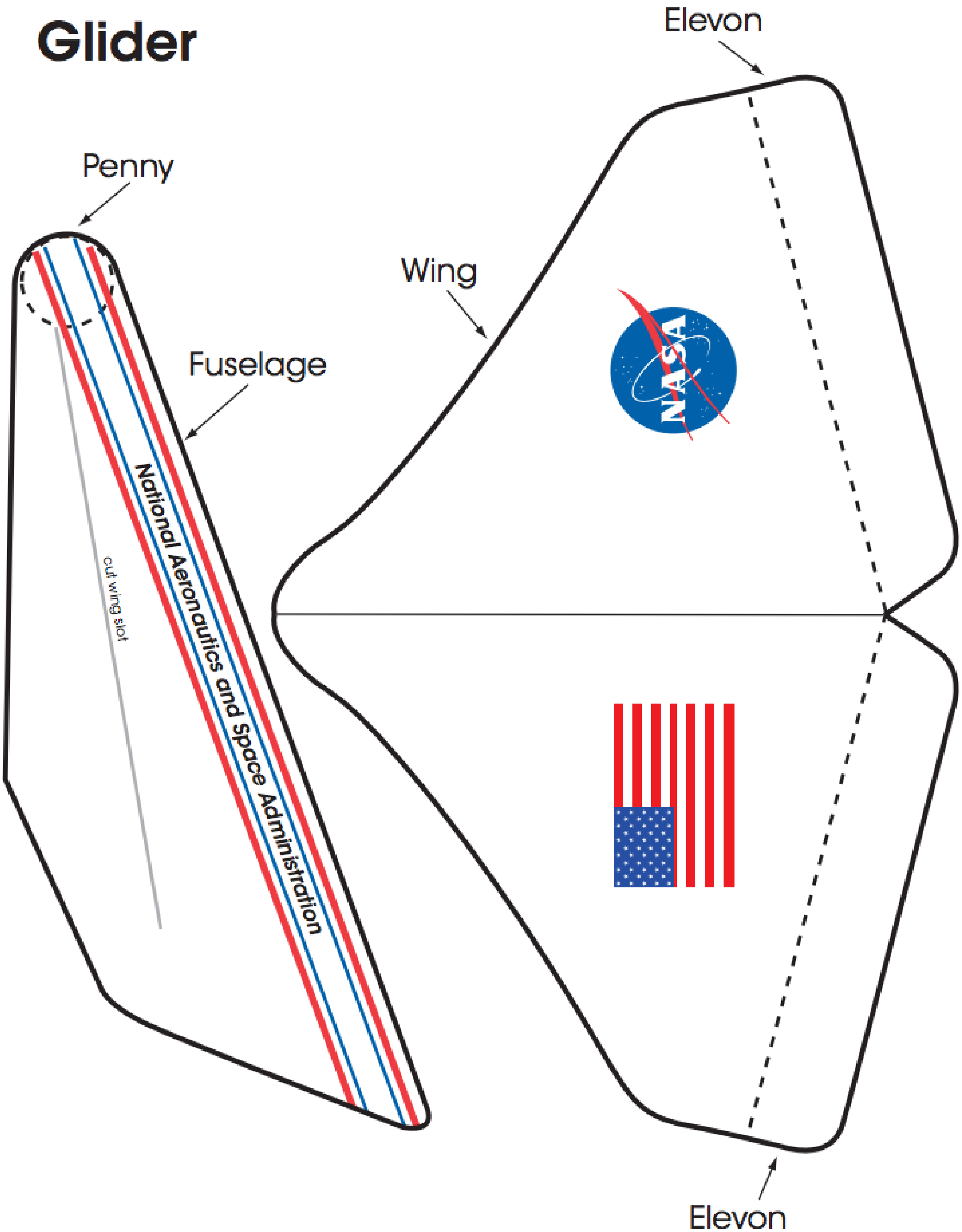
Scissors
Cellophane tape
One penny



Instructions

1. Print the following page on a piece of heavy cardstock, and cut out the wings and fuselage on the next page.
2. Carefully cut on the wing slot line located on the fuselage.
3. Slide the wing into the slot, making sure that the wing center line is within the fuselage.
4. Tape the wing to the fuselage.
5. Tape the penny to the nose of the fuselage for balance.
6. Bend both elevons upward.
7. Gently toss the **glider**.

Glider


Penny
Fuselage
National Aeronautics and Space Administration
cut wing slot
Wing
Elevon
NASA
Elevon

Lesson 2

BALLOONS

Lesson
Balloons

Literature
Hot Air: The (Mostly) True Story of the First Hot Air Balloon Ride

Lesson 2: Balloons

Key Q's
What kinds of things sink/float? Why do some things sink/float? What is weight?

Primary Materials
Balloons w/**air** and w/**helium** (mylar or latex)
Ribbon
Printer Paper
Stapler
Animal templates
Paper lantern
Heat source (hair dryer)
Streamer Paper
Animal templates

Resources
High Flyers e-Book

The first people who took to the skies were balloonists. Balloons offer the opportunity to teach young children about sinking and floating, and to learn about early concepts of volume, density, buoyancy, and weight. In this module, students are read *Hot Air: The (Mostly) True Story of the First Hot Air Balloon Ride*. Children then re-create the hot air balloon ride with helium-filled balloons (latex or Mylar), an origami paper basket, and paper animal cut-outs of the first animals to ride in a hot air balloon: a rooster, a sheep and a duck.

Focus Storybook

Hot Air: The (Mostly) True Story of the First Hot Air Balloon Ride
Cover and illustrations from HOT AIR by Marjorie Priceman

Learning Goals

Language	• Vocabulary: Sinking, Floating. • Writing: Write the letter B.
Math	• Count animals of various types. • Identify objects as having more or less mass/weight.
Science/ Engineering	• Identify objects as floating or sinking. • Identify and describe the properties of solids, liquids, and gasses. • Design a floating object/boat. • Launch a hot air balloon.
Fine Motor Skills	• Fold a simple origami cup.

Science/Engineering: Pre-Reading Activities

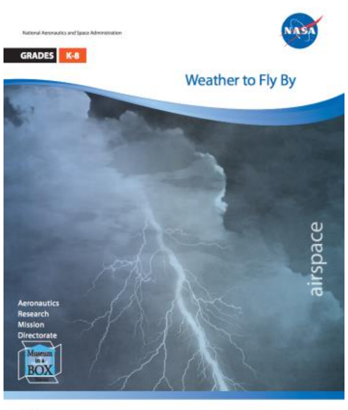
Allow students to investigate floating and sinking objects. On a simple level, ask students to describe what kinds of things sink, and what kinds of things float. Although this concept might be too advanced for some students, be aware that the real difference between sinking and floating objects is *density,* not just mass. The following are some possible supplemental activities to help students understand the concepts of sinking and floating:

Investigation: Sinking and Floating Objects

Classify sinking and floating objects. Provide students with a variety of sinking and floating objects, along with a large tub of water. Allow students to classify objects as sinking or floating, and ask students to hypothesize why some things sink, and why some things float.

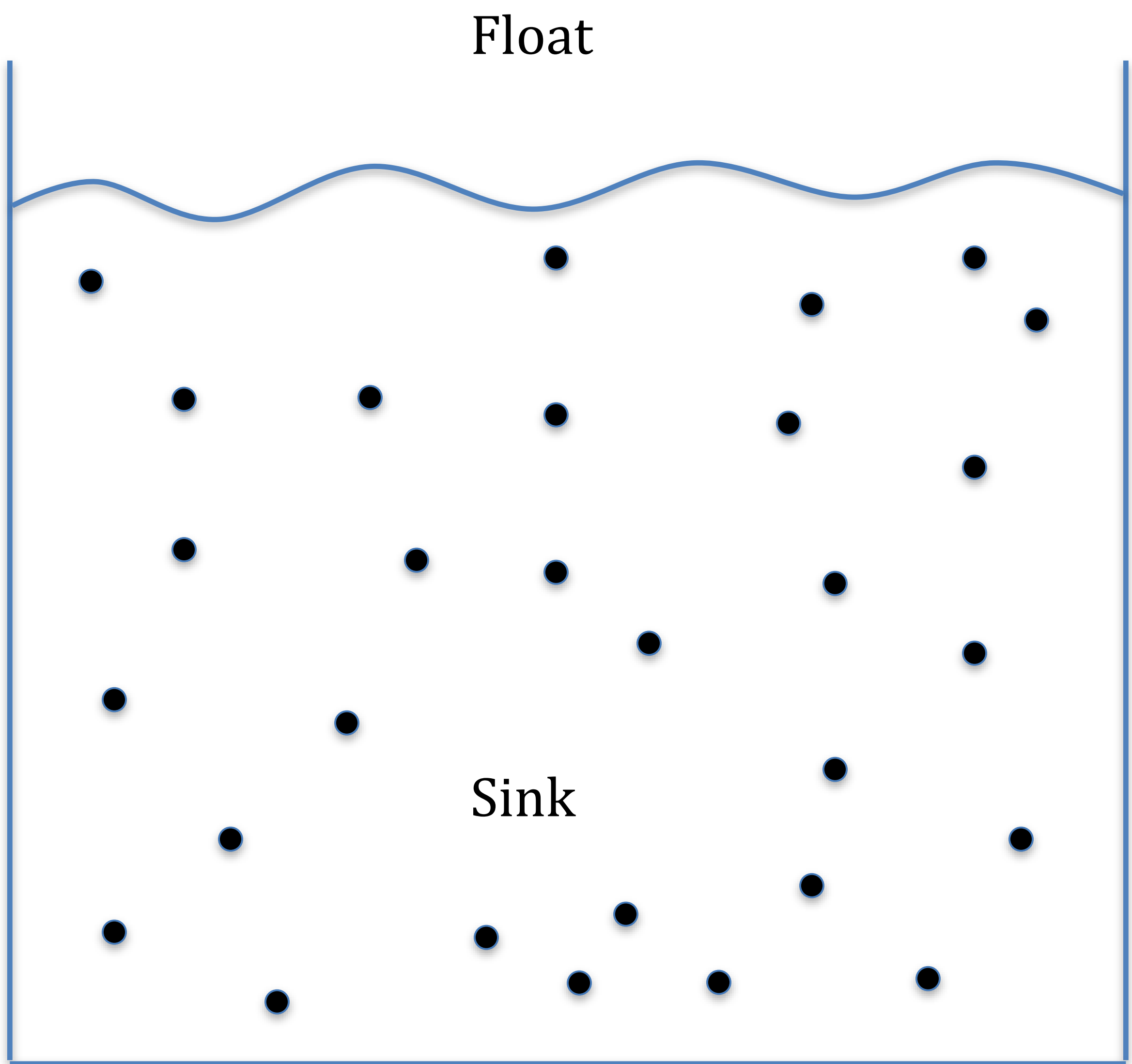
Interactive Demonstration: Soda and Oranges

Provide a cognitive-dissonance activity about sinking and floating. Ask students what they think will happen (sink or float) to two similar objects: 1) a can of regular and can of diet soda, or 2) a whole orange with its rind and a whole orange without its rind. In both cases, one will sink, and one will float. To help students see why an unpeeled orange floats, have students look at the rind under the microscope – they should see small cells filled with gas.

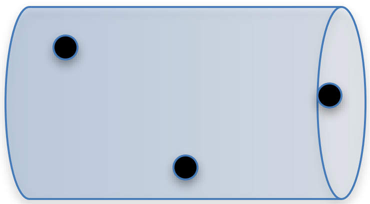


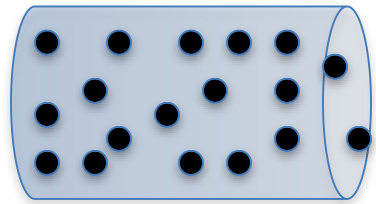
For more information on this soda-can activity, please check out NASA's Museum in a Box, Weather to Fly By lesson for K-8

To help students visualize the difference in density of the two soda cans, use the following worksheet. Prepare cut-out examples of cans with varying densities, and ask students to demonstrate that they know which can would sink and which can would float. *Have students place the denser object on the bottom of the container of the fluid, and the less dense object near the surface of the fluid.* (Note: The denser object will sink, and the less dense object will float).



Cut out the two "cans" below, and ask students to place them on the image above where they would go if they were placed into the "tank of water."





Application: Density Column

Practice pouring in order to create a a colorful density column, and drop small items to see where they land within the column. Use liquids of varying densities (water, cooking oil, corn syrup, maple syrup) and food coloring to make a beautiful density column.

Interactive Demonstration: Sensory Bottles

Create water sensory bottles with colored water and oil, and add glitter, beads, or other small objects for appeal. In particular, ask students to predict how a very massive amount of oil will behave when mixed with a very small amount of water. Students are often surprised to see that the "heavy" oil still floats on top!

Experiment: Floating Boats

Using a container of water, aluminum foil, and small masses or coins, have students build the best boat possible to support the most weight. (Students who maximize volume while minimizing surface area – i.e. spherical boats – tend to hold the most mass!)

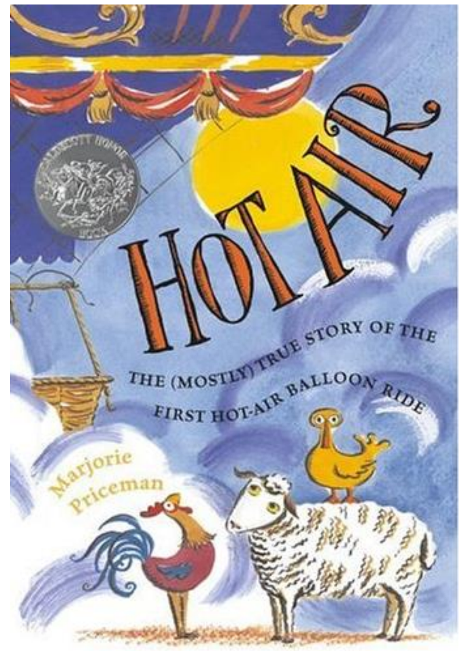
Interactive Demonstration: Salt Water

Demonstrate that a change in the surrounding fluid also can determine if something is going to sink or float. Add salt water to a container with an egg in it. As the salt dissolves in the water, and makes the fluid more dense, students will see the egg begin to float.

Interactive Demonstration: Floating and Sinking Balloons

Provide students with helium-filled and air-filled balloons without telling them that the gasses inside are different. (*Caution: Some schools prohibit the use of latex balloons. Mylar balloons can easily be substituted.) If appropriate, allow students to tug on the helium-filled balloons to feel the upward force, and to compare that to holding an air-filled balloon. Ask students to compare the two balloons.

Reading: Hot Air: The (Mostly) True Story of the First Hot Air Balloon



© Marjorie Priceman

Read *Hot Air: The (Mostly) True Story of the First Hot Air Balloon Ride.* While there is some significant amount of text within the first few pages, and on the last page, most of the story is visual. If possible, ask students to help narrate the story based upon the clues they get from the book.

Use some of the following strategies to engage children:

- On the first page of the book, the large balloon is displayed, surrounded by smoke. Ask children:
  - Why is there smoke around the bottom of the hot air balloon? *The first hot air balloon was filled using a large bonfire.*

- On the second page of text, there is an image of a servant preparing some food for a dog. As he removes the cloche covering the food, steam is shown to be travelling upward. Ask children:
  - What does the purple swirl represent? *The swirl represents steam rising upward.*
  - Why is it going up? *This is a key concept to help students understand that hot air rises, as with the hot air balloon!*

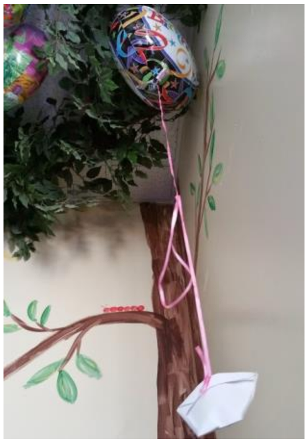
- Have students interact with the animal sounds by repeating them as they are read. *Allow students to make "baa," "quack," and "cock-a-doodle-doo" sounds. Students will be surprised and delighted to hear the rooster go "moo" in the story!*

- Midway through the flight, a group of birds passes by the hot air balloon. Do birds fly in the same way as hot air balloons? What is different? *Hot air balloons float, but birds must flap to stay aloft.*

- Ask students why the balloon first went up. *It was filled with hot air, which is less dense than the surrounding air, so it floats.*

- Ask students why the balloon came back down. *A small bird popped the balloon with its beak, releasing the hot air, and causing the balloon to sink back to the ground.*

Science/Engineering: Book-Based Activities

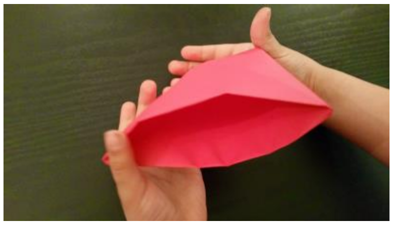
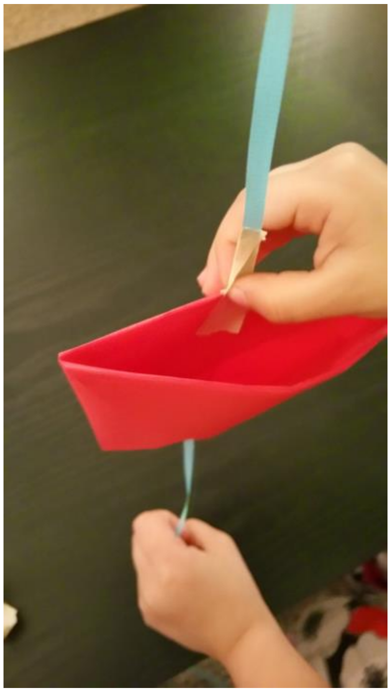
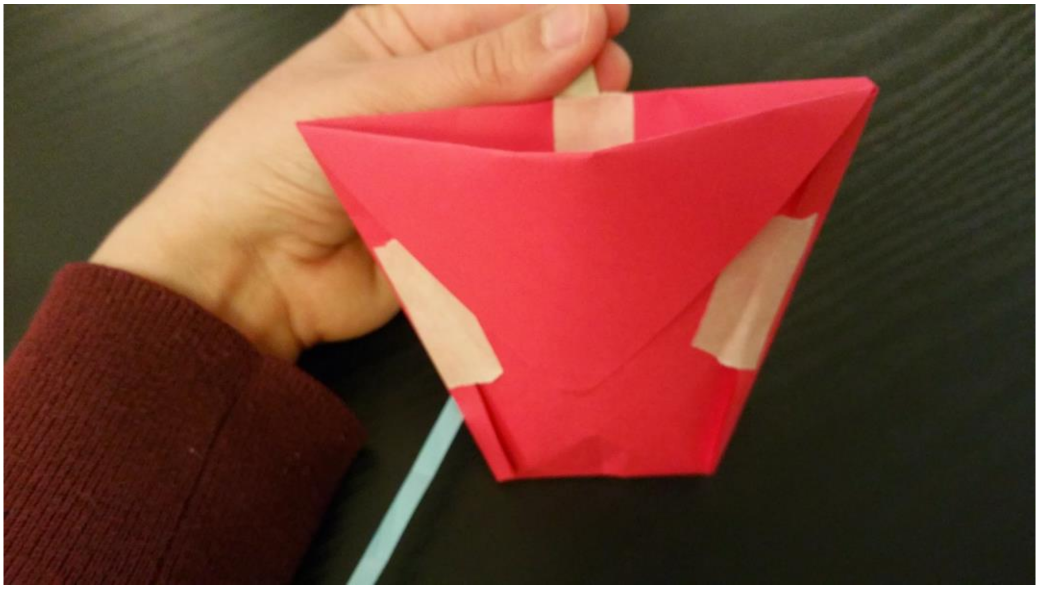


Experiment: Helium Balloon Activity

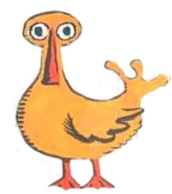
Model the use of balloons to lift up weight by creating a model air balloon with one or more of the helium balloons. Either create a "basket" or have students create a basket by making an origami cup. (Note: To lighten the weight of the "basket," consider cutting off any excess flaps.) Staple or tape the balloon basket to the ribbon of the balloon.





Provide students with an adequate number of cut-outs of the animal templates provided. Use standard printer paper, so that multiple animals can be supported by the balloon in the basket before sinking. Allow students to add one animal at a time, to see how many animals can be supported by the balloon until it begins to sink.



Have students count the animals of each type that fit into the basket. Supplemental activities to go further:

a. Compare balloon sizes (volumes). Using the same animals, see how the size of balloons affects the number of animals that can be held. (Bigger balloons tend to hold more.)

b. Compare animal sizes. Using one animal of each type per trial, see how many animals can be held when filling the basket only with ducks, roosters, and sheep. (Balloons should hold fewer of the larger animals, due to their mass, and the equivalent mass of the larger paper).

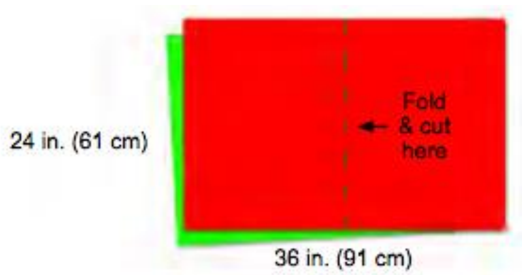
Interactive Demonstration: Hot Air Balloon

However, in this case of *Hot Air*, the helium-filled balloon does not work as hot air balloons do. To demonstrate this, launch a hot air balloon. Paper balloons can be easily built with tissue paper, or purchased as Chinese lanterns. (Caution: Use a hair dryer or other safe heating device – never launch a Chinese lantern for lessons using the provided candle sold with commercial Chinese lanterns, as this could be both dangerous as well as interfere with FAA regulations.)

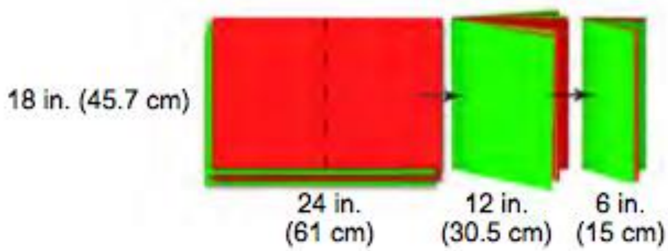
See instructions on the following page for how to build your own hot air balloon from tissue paper.

To make your own hot air balloon in advance of lesson, follow these instructions, and visit The Courage to Soar: Lesson 14 – Discovering the Properties of Air. Note: Ensure that this hot air balloon is capable of flying before trying with the class! It might be necessary to use a heat source much more powerful than a hair dryer. Instructions for heating the hot air balloon with a grill and stovepipe are included in the referenced document. Please consider safety when doing such activities with very small children.

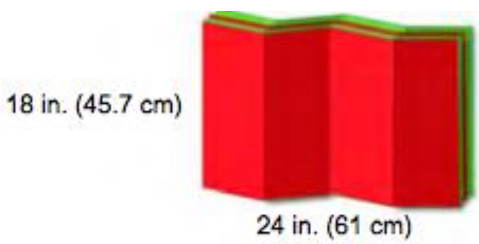
1. Fold two sheets of different colors of tissue paper in half. Cut both sheets on the fold.



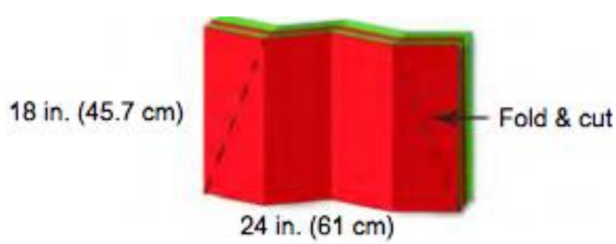
2. Place these four sheets on top of one another, and fold in half again. Then fold in half (lengthwise, again).



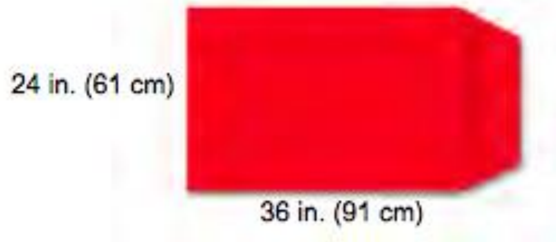
3. Open. There should be three vertical folds dividing the paper into four equal panels.



4. On the far right panel, make a diagonal fold from the bottom right corner to the top of the nearest fold. One the far left panel, make a diagonal fold from the bottom left corner to the top of the nearest fold. You should now see the shape of the trapezoid. Cut on the outer diagonal folds to make four trapezoids.

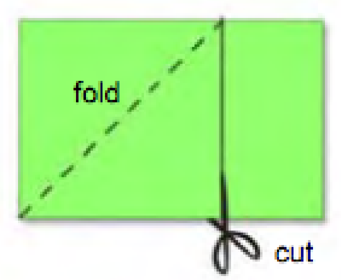


5. Lay a large (uncut) sheet of tissue paper on the table. Glue the long side of the trapezoid to the bottom of the sheet. They should match up to be the exact length. Repeat this process until each of the four large sheets has a trapezoid glued to the bottom. Make sure the glue is thick and continuous so that no air can escape.



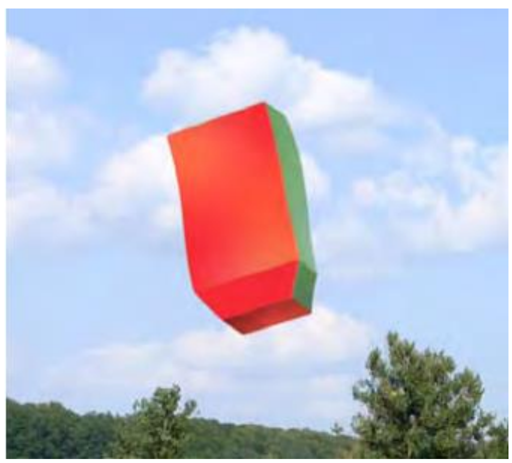
6. Glue the four panels together so that they become the sides of the balloon. Then glue the four trapezoids together so that they form a funnel-like opening at the bottom. Again, make sure that the glue is thick and continuous.

7. Using the last sheet, take the upper right corner and fold it over diagonally until it touches the bottom edge and the two bottom edges line up. Cut along the left edge of this folded triangle so that the rest of the panel becomes detached. Open the triangle to produce a square. Thoroughly glue this square onto the four panels to form the top of the balloon.



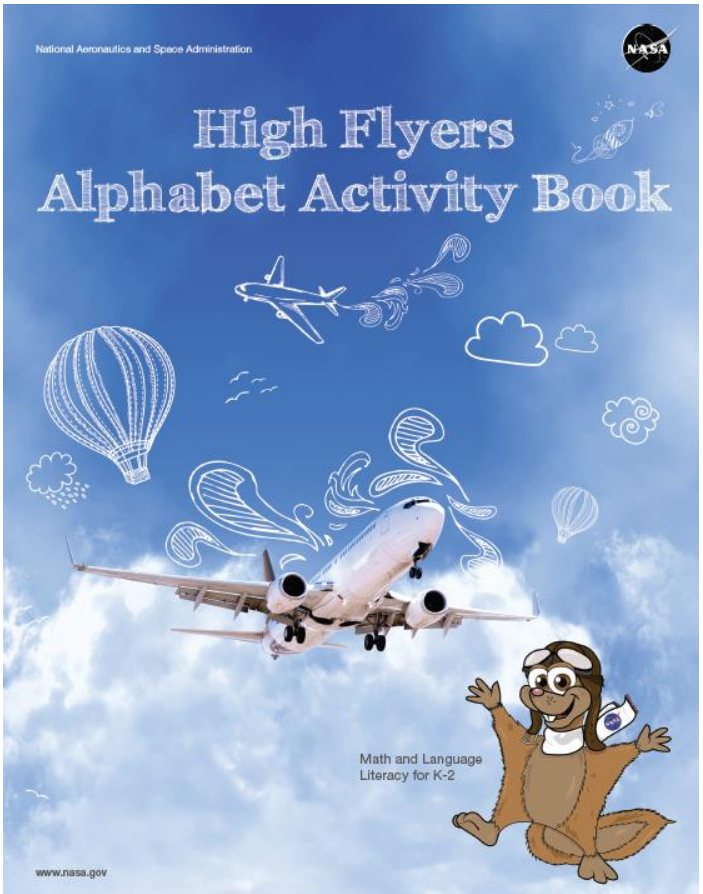
8. Tape four pennies or paper clips at the bottom where the edges of each trapezoid meet.

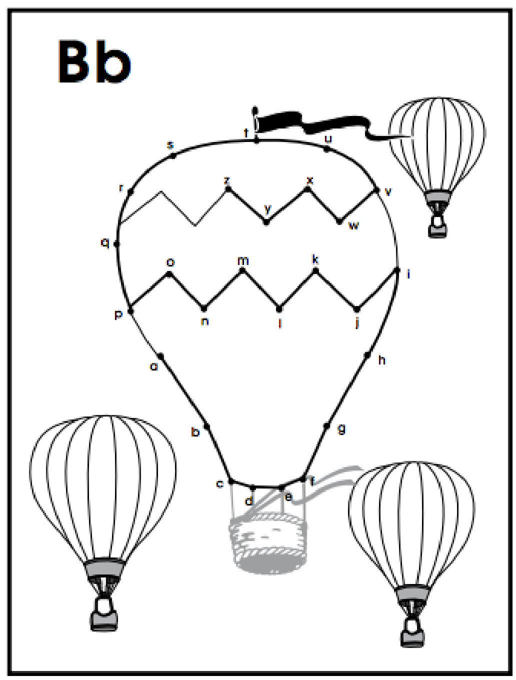
9. Let the glue dry overnight.



Writing: "B"

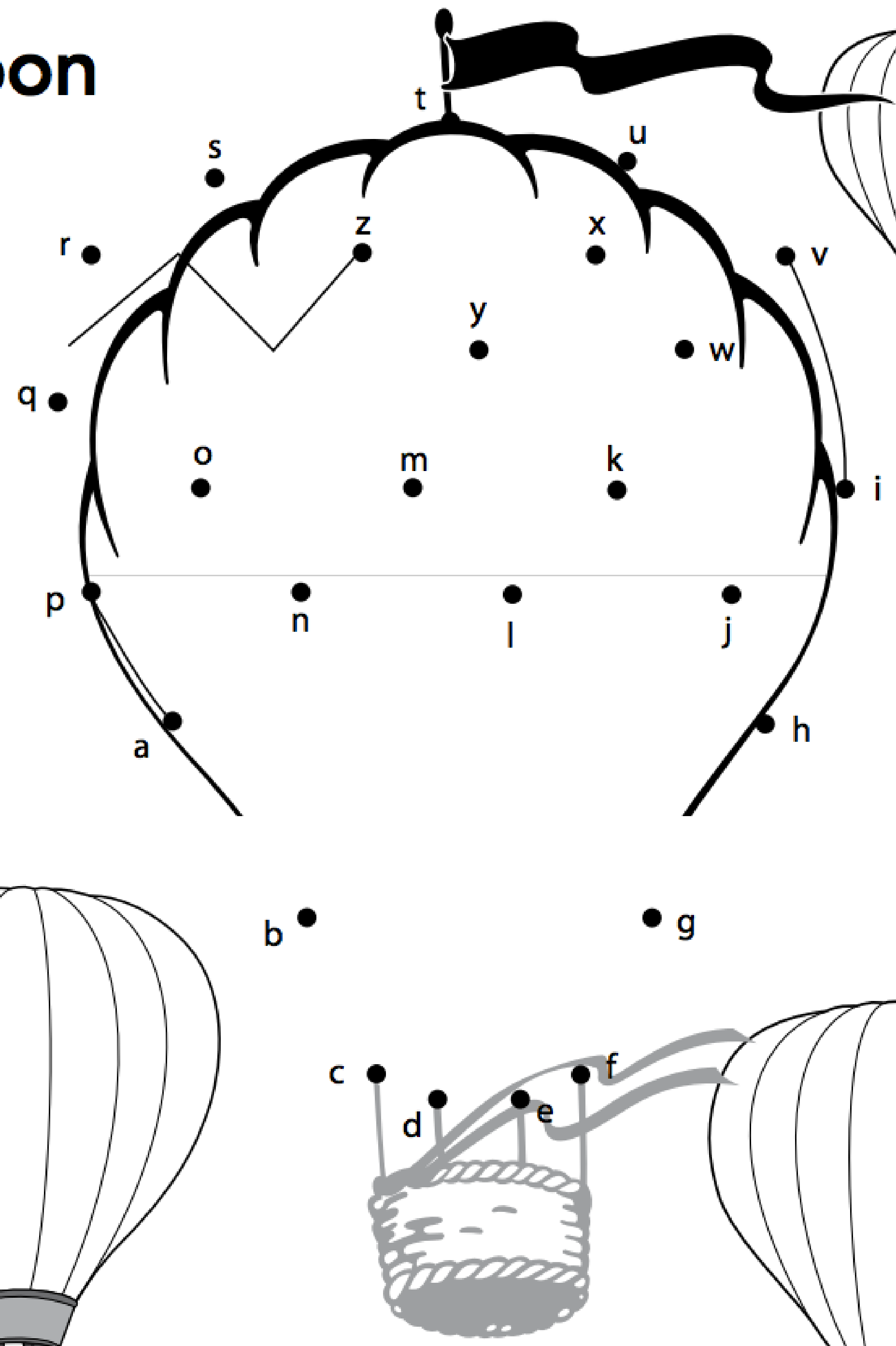
Practice writing the letter B. Use NASA's High Flyers Alphabet Activity Book.

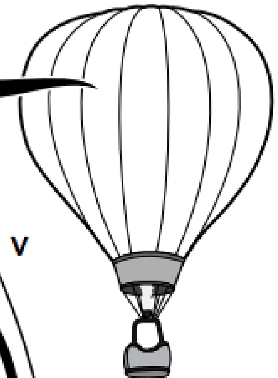


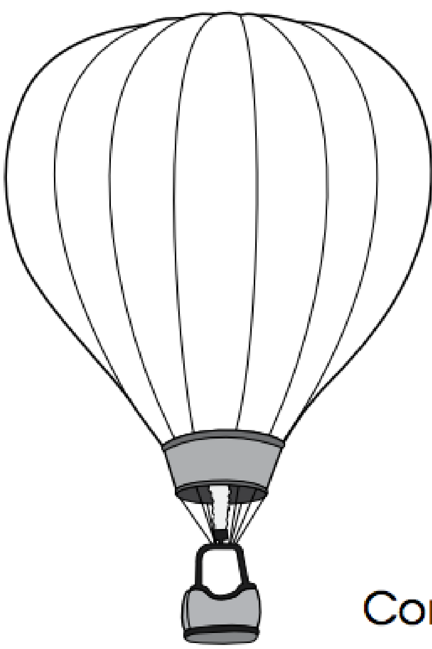


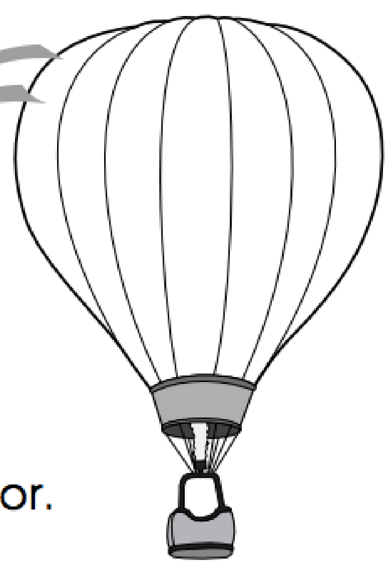
Bb Bb

balloon

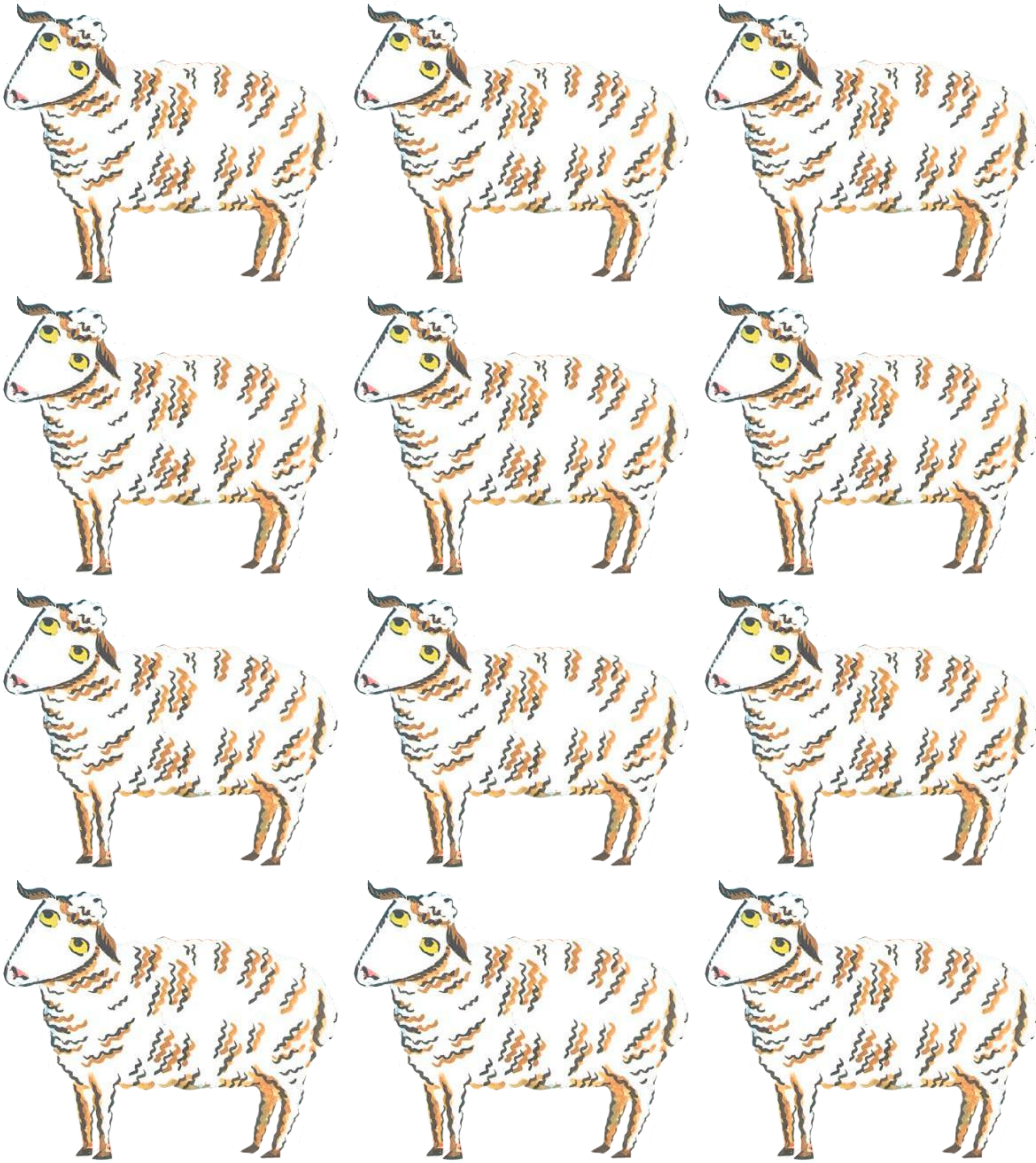


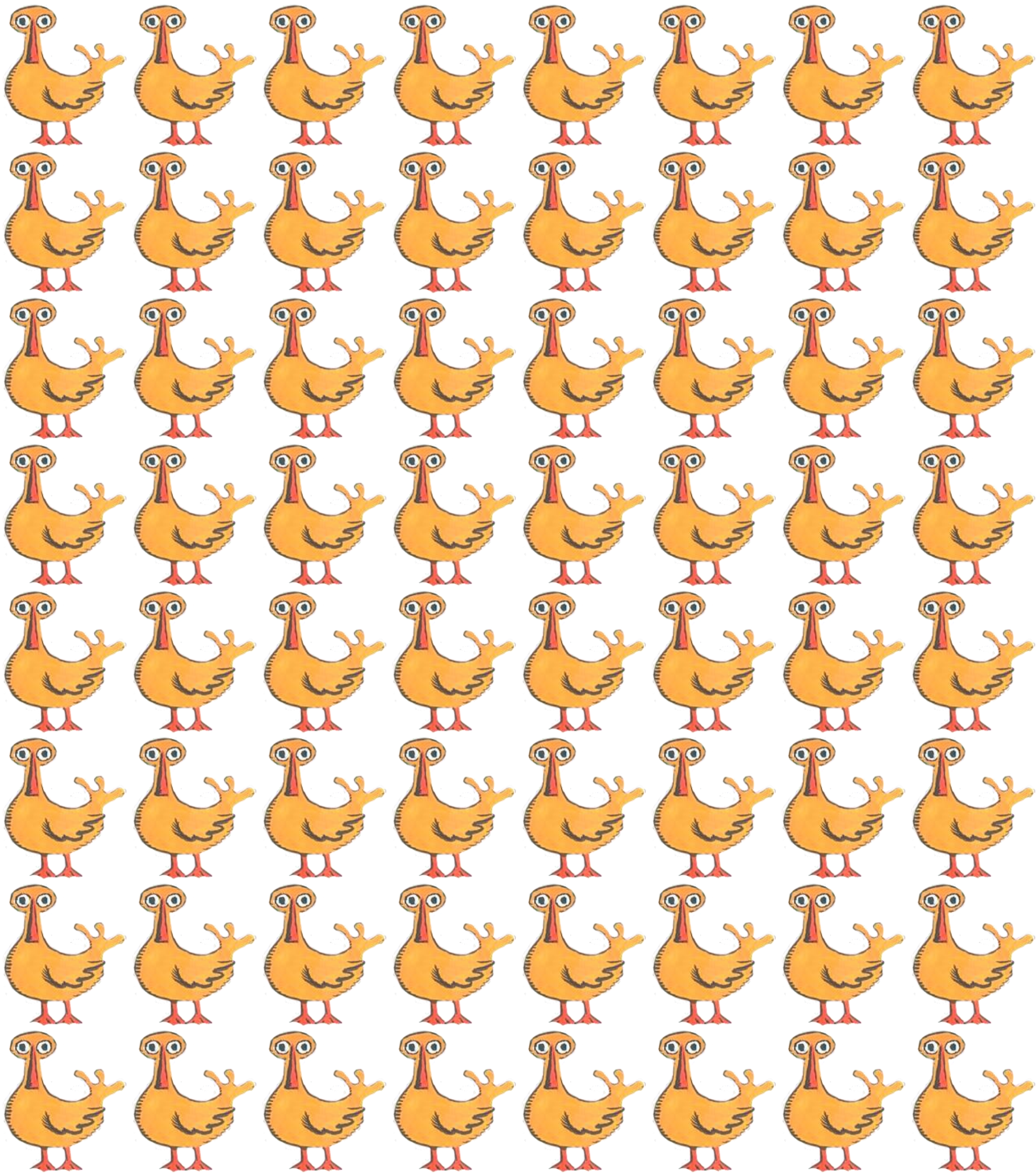






Connect the dots and color.





Illustrations from HOT AIR by Marjorie Priceman

Lesson 3

Parachutes

Lesson 3: Parachutes

Key Q's
What makes some objects fall faster than others? What slows objects down as they fall? What is drag?

Materials
Coffee filters
Viscous fluids (water, soap, corn syrup, or combinations thereof)
Tubes/cylinders (large syringes used for basting turkeys are best)
Plastic eggs/ping pong balls
String
Tape
Parachute materials (tissue paper, wrapping paper, plastic bags)

Resources
High Flyers e-Book

Parachutes are an opportunity to teach young students about fluid thickness and for them to learn about early concepts of drag. In this module, students are read *Egg Drop*, a story about an adventurous egg that dreams of flying. The egg considers all of the ways that it could fly, but finally settles on climbing a large tower and jumping from it. Unfortunately, the egg had not thought ahead to use a parachute – it breaks and becomes someone's breakfast meal. Children then use this story as an inspiration to create a parachute for their own "egg" (plastic egg, or ping pong ball) while learning about how surface area, shape, and weight affect the fall time of the egg and parachute.

Focus Storybook

Egg Drop
Cover and illustrations from EGG DROP by Mini Grey

Knopf Books for Young Readers

Learning Goals

Language	• Vocabulary: Parachute, friction, up, down, fast, slow. • Writing: Practice writing the letters "U" and "D."

Math	• Time a parachute fall. • Identify shapes.
Science/Engineering	• Describe air resistance. • Identify variables that might affect air resistance. • Compare the time of fall for different objects. • Design a parachute.

Science/Engineering: Pre-Reading Activities

Experiment: Coffee Filters and Marbles

In the book *Egg Drop*, an egg wants to fly, and ultimately jumps from a tower and breaks upon hitting the ground. The key idea is that the egg could have slowed itself down if it had a way to take advantage of drag, a concept very closely related to friction generated through air. To help students understand drag, give students as many experiences as possible:

a. Compare the fall time for one coffee filter (light) versus multiple coffee filters in a single stack (heavy). Make sure that students drop the coffee filters from shoulder height, and that they are released at the same time. *The heavy coffee filter stack should hit the ground much more quickly than the single coffee filter. (Note: Children are often erroneously taught that all things fall toward the Earth at the same rate. While this is true when there is no (or negligible) drag, this is not the case when the object falls through a fluid such as air).*

b. Compare the fall time for a regular coffee filter (large surface area) versus a crinkled coffee filter (small surface area). Make sure students drop the coffee filters from shoulder height, and that they are released at the same time. Consider allowing children to modify their own single coffee filter by crunching it or folding it to decrease its total surface area. *The crinkled/balled-up coffee filter should hit the ground much more quickly than the single coffee filter.*

c. Compare the fall time for a marble (or other sinkable object) through a clear tube/tall cup/bottle of water, soap, and/or honey. Alternatively, use test tubes or large syringes (like turkey basters) to make “viscosity tubes” to observe the speed of air bubbles or marbles traveling through the fluid. Use hot glue to close off the ends of the syringes so that fluid does not come out. For small children, it is best to use a totally enclosed container so that the children can turn it over and upside down again and again. *Children should find that some fluids are thick and other fluids are thin. Marbles or other heavy objects take a long time to travel down a tube of very thick fluid (like soap, corn syrup, or honey), while they travel very quickly through thin fluids (like water).* Help students to understand that air produces drag on falling objects, so it does have some thickness, but it is not as thick as liquids such as water or corn syrup.

d. Hold a plastic bag by its handles in front of or above a fan on the floor that blows air. Students can feel the upward push of the air on the “parachute” bag.

Reading: Egg Drop

Cover and illustrations from EGG DROP by Mini Grey
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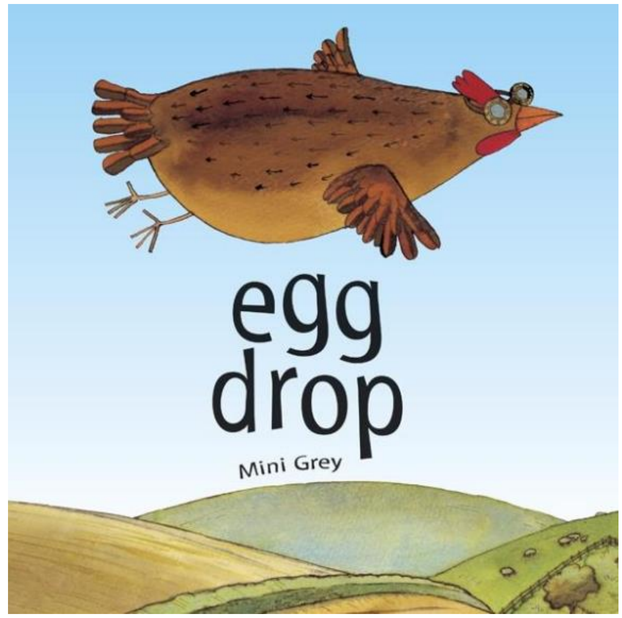
Knopf Books for Young Readers



© Mini Grey

Read *Egg Drop.* As the story is read, encourage children to think about how the egg could have safely flown using drag to its advantage.

Additionally, to engage the listeners, consider using the following strategies:

- Point out the scientific/technical pictures as the egg considers the many ways to fly. Ask students to list the images they see – helicopters, airplanes, parachutes, gliders, wings, rockets, blimps, etc.

Egg Drop, **pg. 10-11. © Mini Grey**

- Have students explain why the egg broke. *Help children to understand that most things speed up as they fall. The egg fell from a very high tower, and because it didn't have a parachute, it sped up throughout its fall, and crashed into the ground at a very high speed. Although a fairly large, light egg could potentially reach terminal velocity before hitting the ground, this concept is likely beyond Pre-K children.*

- Have students explain what the egg could have done to keep itself from breaking. *It could have used a parachute to slow itself down, or some other device to help it to float upward (such as a hot air balloon, blimp, or helicopter propellers).*

Application Lab: Parachute Building

Help students create parachutes – try to have the slowest fall possible!

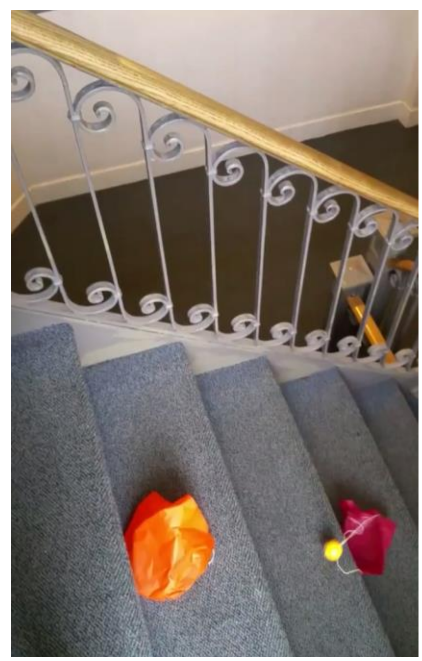
1. Provide students with string, tape, scissors, and a variety of types of paper or thin plastic, and allow students to choose the size and shape of their parachute. *For younger children, prepare in advance rectangles (quarters) of tissue paper, four strings, and four bits of tape to attach the strings to the corners of the rectangle.*

2. Allow students to attach strings with tape.

Egg Drop, pg. 9. © Mini Grey

3. Allow students to choose the type of parachuter – in line with *Egg Drop*, consider using plastic Easter eggs, filled with varying amounts of coins or sand, and sealed with tape. *Children should think about what kind of parachute would result in the slowest fall (Should it be light or heavy? Big or small?)* Encourage students to personalize their egg by adding a face/eyes/goggles, etc.

4. Drop the parachutes from a stairwell, window, or ledge. Caution: Ensure that there is no risk of children falling, and that it is safe to drop the parachutes on the ground below. Ideally, choose a location in which it is easy for all children (the droppers and the observers) to see the parachute as it falls the entire way. Have students identify the slowest parachute.



Interactive Demonstration: Group Parachute

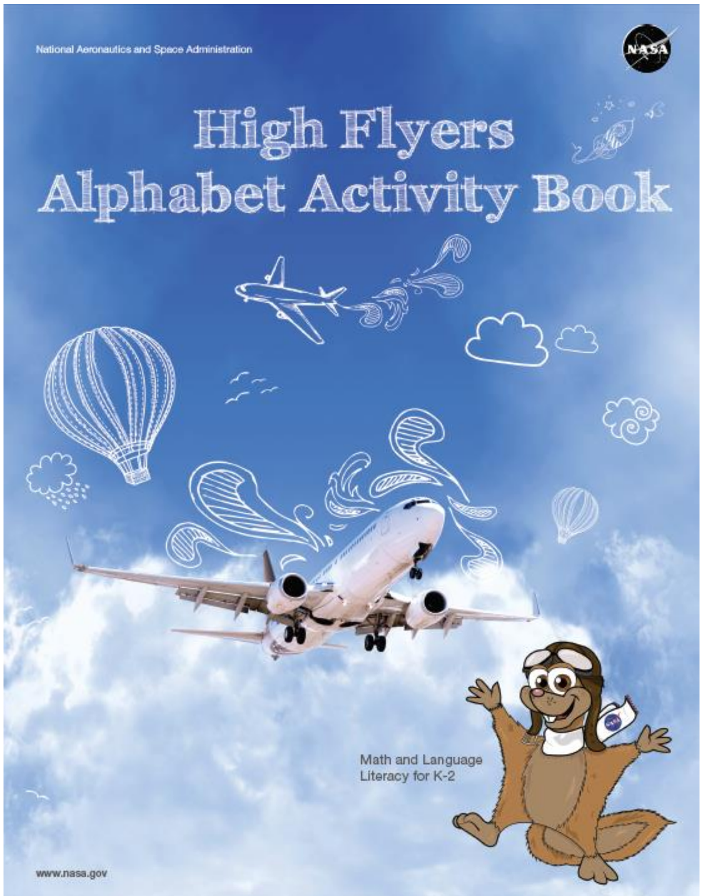
Many libraries, schools, and informal education centers have very large parachutes for circle time. Although typically used as an opportunity to have students learn to follow instructions, cooperate, and sing songs, the parachute also gives teachers and leaders the chance for young children to experience the impact of air on an object that is falling.

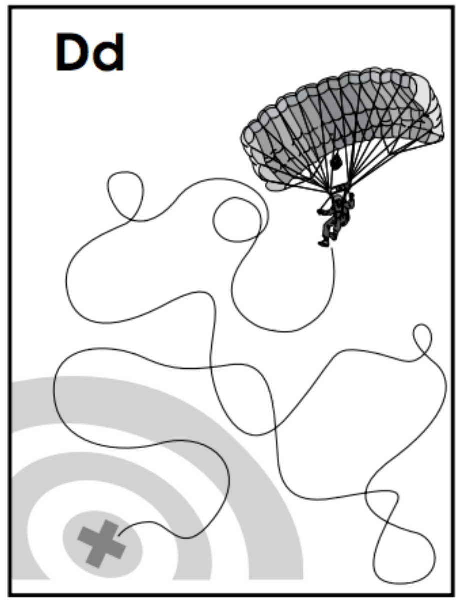
1. Have children lift and lower the parachute with *tall* strokes (not just “shaking” the parachute, but actually lifting it.) Is this easy or hard to do? Why? *Students should notice that it is actually rather difficult – the parachute might be a little bit heavy, but it is even difficult to lower the parachute more quickly than it wants to fall on its own, because air gets in the way, and air is actually quite viscous!* (This is how parachutes work – but “capturing” some air as it falls).

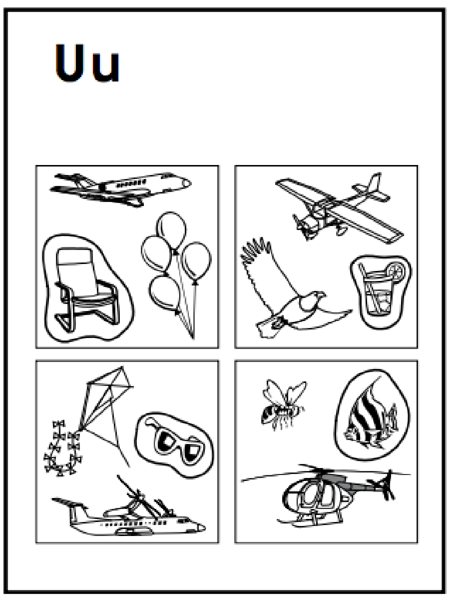
2. Have half of the children go under the parachute while the remaining children hold onto the parachute. Ask the children under the parachute to explain what they feel (wind). Then, take turns.

Write: “D” and “U.”

Practice writing the letters D and U. Use NASA’s High Flyers Alphabet Activity Book.



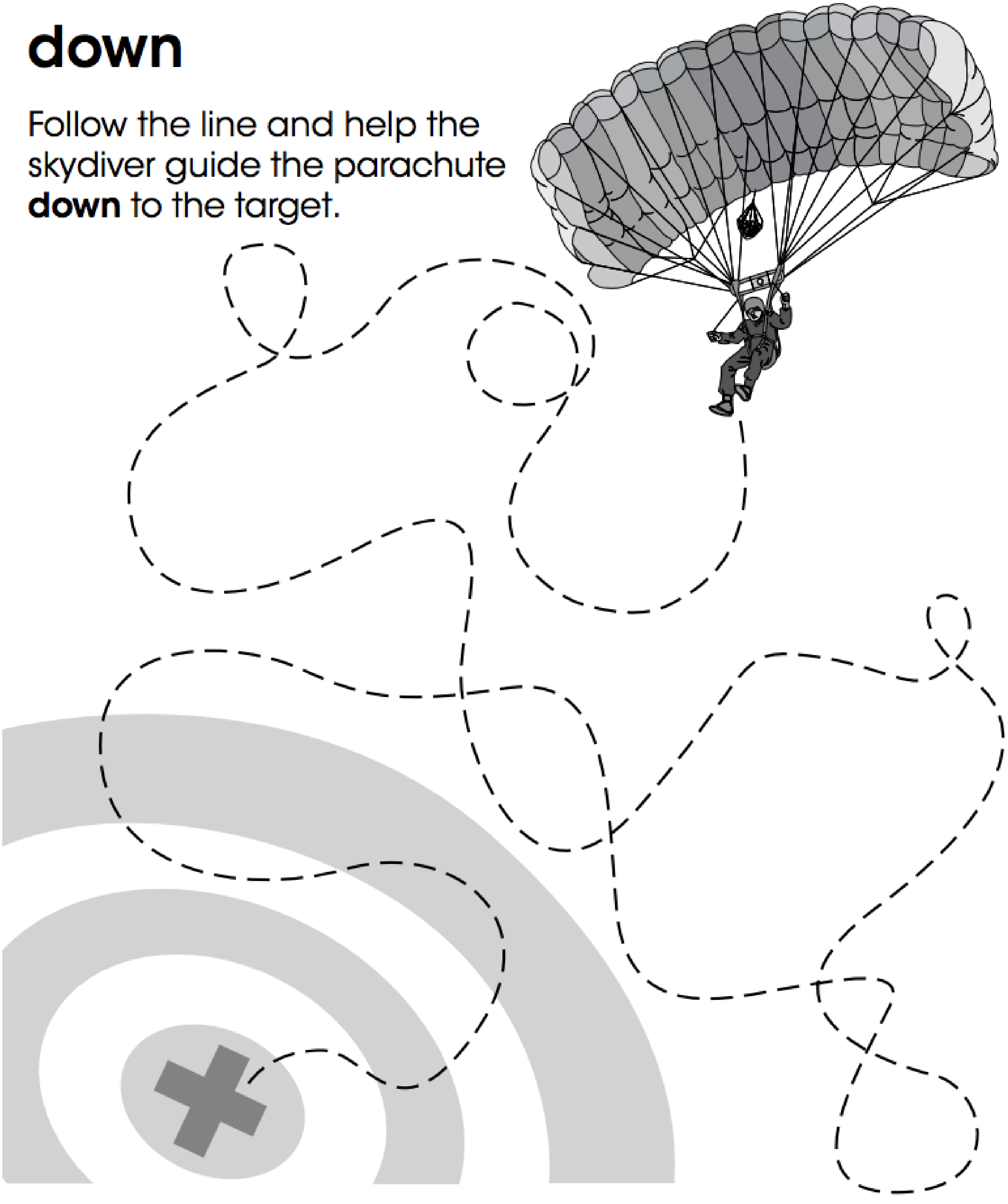




Dd Dd

down

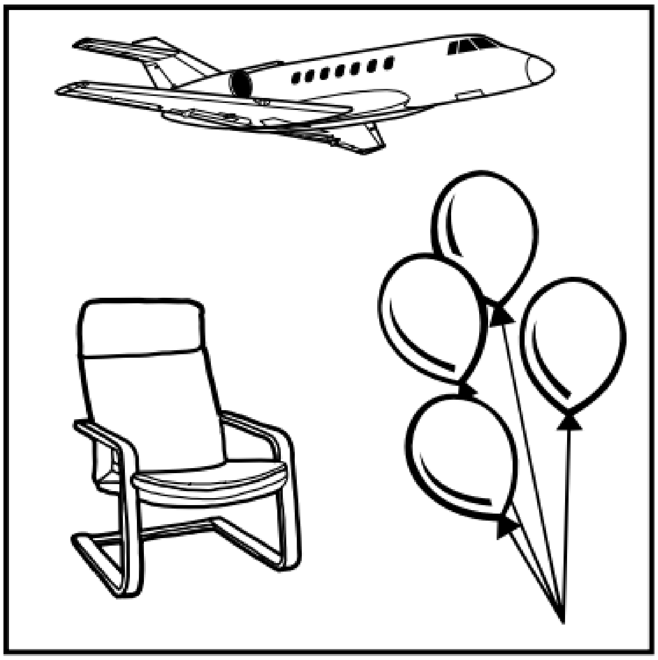
Follow the line and help the skydiver guide the parachute **down** to the target.

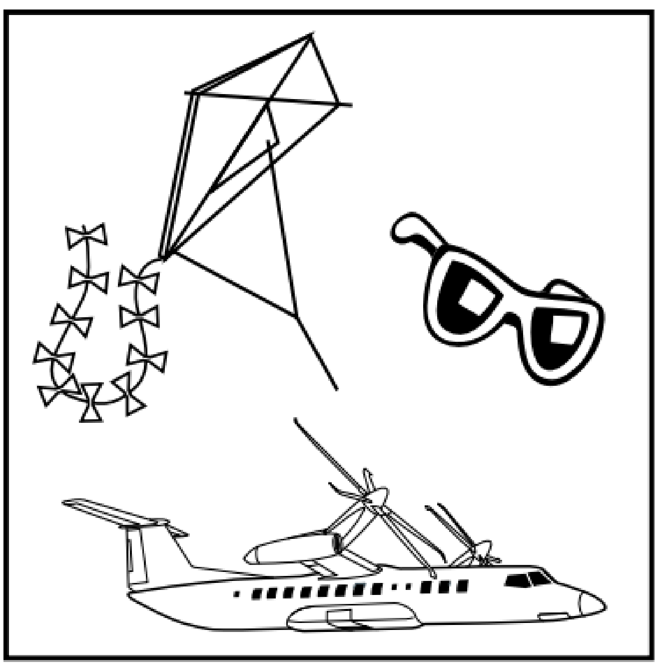


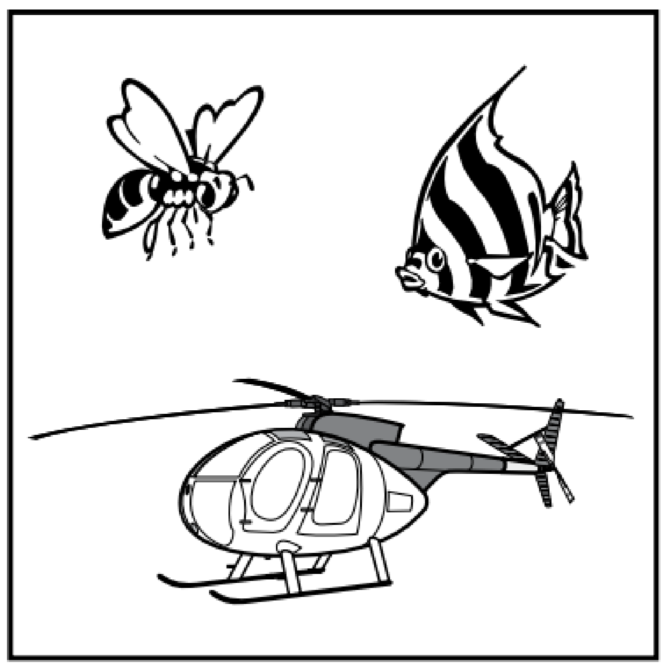
Uu

up

Circle the object in each group that does not go **up** in the air.







Lesson 4

Kites

Key Q's
What materials are needed to make a good kite? What is lift?

Materials
Paper (printer, cardstock, and tissue)
Cardboard samples
Scissors
Tape
Straws
Feathers
Popsicle sticks
Fabric belt
Map
Napkins
Band-Aids
Ball of yarn
Kite
String
Tissue Paper
Wax Paper
Iron

Resources
High Flyers e-Book

Lesson 4: Kites

Kites (a type of glider) provide an opportunity to teach young students about early concepts in material science and lift. In this module, children read a story about the creation of a kite in *The Kite Festival*, a story that includes a simplified engineering process including design, material selection, testing, and optimization (improving the design). Afterward, students create their own kite for flying, as well as a craft kite suncatcher.

Focus Storybook

Kite Festival
Cover and illustrations from KITE FESTIVAL by Leyla Torres

Farrar, Straus, and Giroux

Learning Goals

Language	• Vocabulary: kite, glider. • Writing: Practice writing the letter "K."
Science/ Engineering	• Compare materials based upon their weight (light vs. heavy). • Compare materials based upon their strength (weak vs. strong). • Choose materials that are most appropriate for building a kite.
Art	• Decorate a kite "suncatcher" with a variety of colors and shapes.

Science/Engineering: Pre-Reading Activities

Inquiry Experiment: Build and Test a Simple Straw Glider

Build a number of other types of gliders to demonstrate how many different shapes can sail across and through the air.

1. Provide each child with a "non-bendy" straw.
2. Provide each child with 1-inch thick strips of paper about 4.5 and 6 inches in length.
3. Help each child make loops with their paper strips, and then to tape them to a straw, as shown in the figure above.
4. See Loop Airplane for more information.
5. Test the Simple Straw Glider by changing different aspects of the glider:
    a. Throw the glider with either the small loop or large loop facing forward.
    b. Throw the glider side-ways.
    c. Move the loops to different positions along the straw.
    d. Plug the front end or back end of the straw with a bit of modeling dough or clay.
6. Students will find that changing any of the variables on their straw glider influence both the center of mass (i.e. balance) of the glider, as well as the amount of lift that is produced.

Reading: The Kite Festival

Cover and illustrations from KITE FESTIVAL by Leyla Torres
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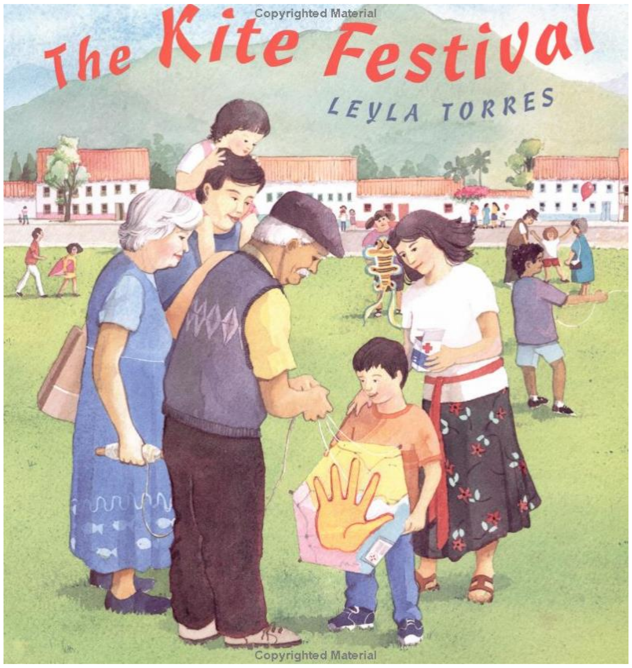
Farrar, Straus, and Giroux



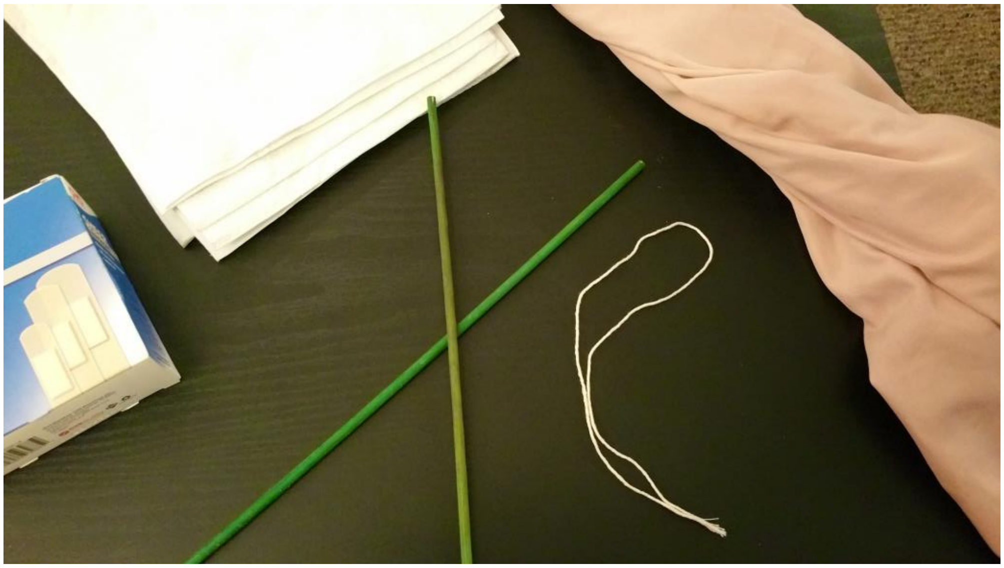
© Leyla Torres

Read *The Kite Festival.* As you read the story, encourage engagement by using the following strategies.

- Hand each child one object in order to role-play throughout the story. To ensure that all children can participate, prepare duplicates of as many items as possible.
  - Popsicle sticks (wooden sticks purchased by the grandfather)
  - Ball of string/yarn (string from the pull-toy)
  - Fold-up paper map (map used to make the paper kite)
  - Band-Aids (Band-Aids from the car used as an adhesive)
  - Fabric belt (fabric belt from the mother's dress)
  - Napkins (from the picnic basket, to make the tail)

- As the story is read, choose one student to be the main character. As the child in the story receives different materials, allow the student to collect the appropriate items from the "audience" members. Once the kite is created, have the child pull out a kite for the other children to see.

- This story is about the resourcefulness of the family, who depend upon their creativity and their ability to reuse and recycle. Ask children what kinds of things they do to reuse and recycle.



- This is also a story that incorporates aspects of the engineering process. A simplified view of the engineering process is shown below, taken directly from the Next Generation Science Standards framework. Encourage students to identify the parts of the engineering process in the story:
    - **DEFINE:**
        - The characters of the story needed to design a kite using only wooden sticks and the materials they had with them.
    - **DEVELOP SOLUTIONS:**
        - Identify criteria (a kite should have a large area but not weigh very much; it should be stable).
        - Identify available materials and select materials for the task (materials that were purchased or available).
        - Build the kite.
    - **OPTIMIZE:**
        - Test-fly the kite. When the kite was first flown, it was unstable because it had no tail.
        - Design a tail, build it, and test-fly it again.

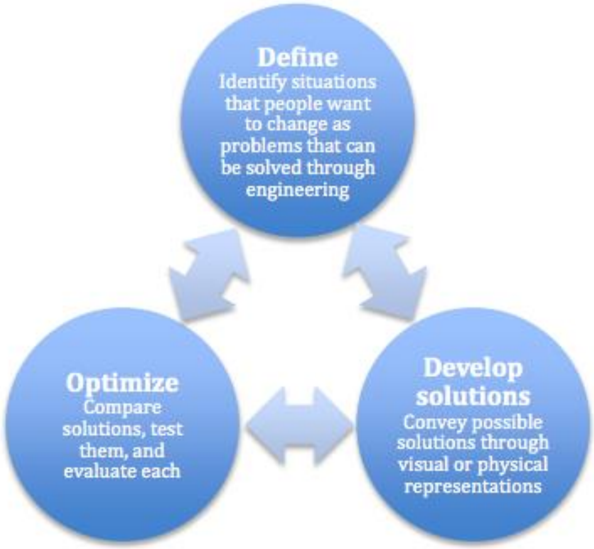


Image Credit: NGSS

Science/Engineering: Book-Based Activities

Discovery Lab: Materials Science

In the book, *Kite Festival*, the family had to make many decisions about the types of materials to use to accomplish their task to build a working kite. This activity will help students to consider both weight and strength as determining factors for building their own kite.

One of the things that helped the Wright brothers to be the first people to successfully fly a controlled and powered heavier-than-air aircraft was that they were experts in working with materials that were both strong and lightweight (they both owned and worked in a bicycle shop before they began building airplanes). In fact, one of the most important aspects of engineering is choosing the right materials for the job. Gliders must be both <u>light</u> and <u>strong</u>.

1. Provide each student with a bird feather (synthetic is fine, but a real bird feather is best). Allow them to toss the feathers into the air, to feel them, and to “weigh” them in their hands. Ask the children why they think birds fly so well. *Help students to recognize that feathers are very LIGHT. In fact, a real bird feather is hollow inside the main rib. Likewise, bird bones are hollow inside to make them lighter. Bird feathers also act a bit like a parachute, because they can “catch” air easily. Bird feathers are also very STRONG for their light weight. In the same way, building a kite or building airplanes requires the use of materials that are both light and strong.*

2. Provide the children with a set of materials for making a simple kite. Provide them with:
- Printer paper
- Cardstock
- Construction paper
- Cardboard
- Tissue paper

3. Encourage them to rank the papers based upon WEIGHT. Ask students to hold equal sizes of paper in each hand, and to compare them. *Children should classify tissue, printer, and construction paper as relatively light, while cardstock and cardboard as relatively heavy.*

4. Next, ask students to rank the papers based upon STRENGTH. Allow children to take designated test strips of print paper, cardstock, construction paper, cardboard, and tissue paper, and attempt to break them by pulling. (Most kites will undergo a stress that is much similar to the material being pulled apart rather than torn). *With the exception of tissue paper, children will find that most of the materials are actually rather difficult to break when being pulled evenly apart!*

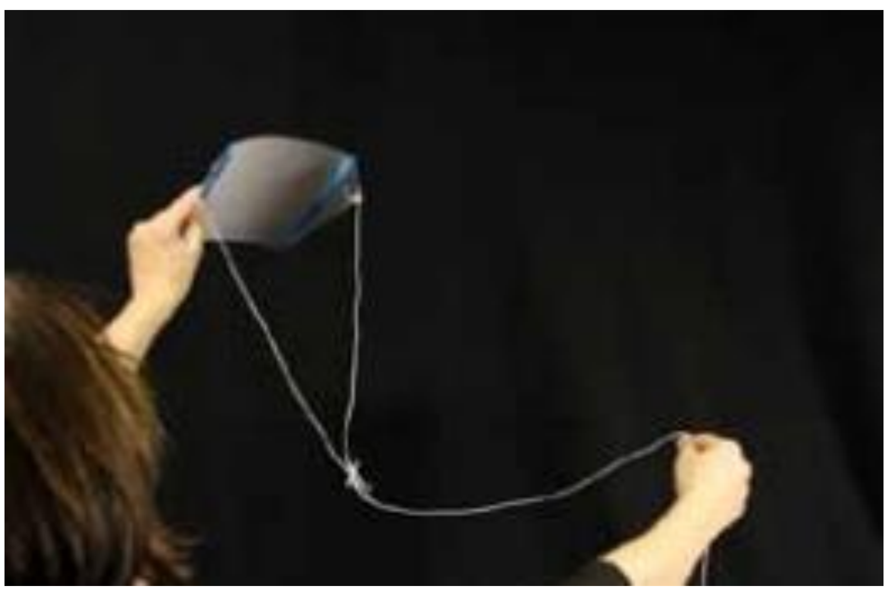
5. Considering that materials to build a kit must be both *light* and *strong*, ask students to determine which materials would be best for building their own kite! *Printer paper is the best option for this task, and is used in the activities noted below.*

In the back of the book, *The Kite Festival*, has some excellent and clear instructions for building a robust, stable hexagonal kite. Although it would be nice to display the construction of such a kite to children, very small children can assist building a simpler sled kite.

For small children, the teacher should provide a pre-cut template and pre-cut straws.

Application Lab: Kite Building

Before building a sled kite, carefully demonstrate the use of a small kite in a safe area outdoors away from electrical lines, or inside a large gymnasium. Prepare to have a child try to safely run/pull tight on the kite. Then, if appropriate, show how it can be easier to fly a kite using a constant flow of air (with a fan). Consider using NASA Museum in a Box First Flyers for additional activities.



In *The Kite Festival*, the main character makes a kite from paper from a road map. This is a wonderful opportunity for children to learn about the purpose of maps and their geographic features.

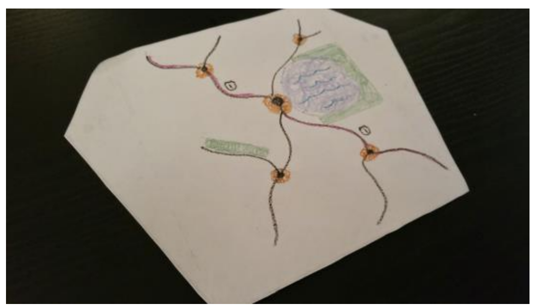
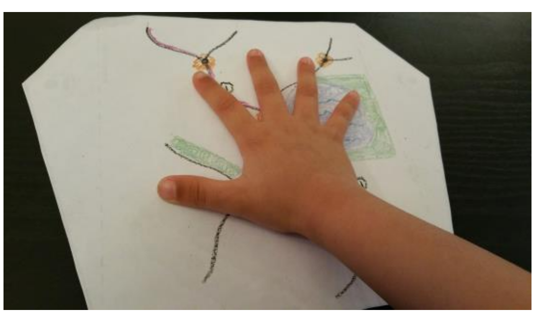
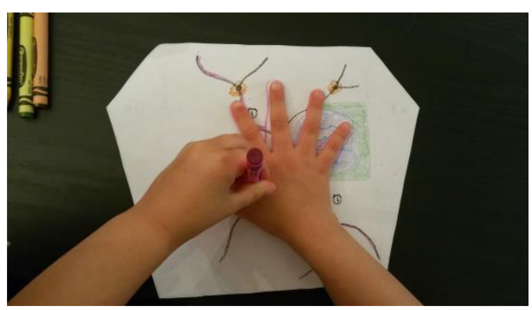
1. Provide each student with a sled kite template.

2. Show children an actual road map. Ask students to identify major features of the map (roads, cities, bodies of water, parks, major attractions, etc.).

3. Ask children to create a map of their own design, and to include some of the features discussed.

4. To add another element of *The Kite Festival*, encourage children to personalize their map by outlining their hand and filling it in with color.

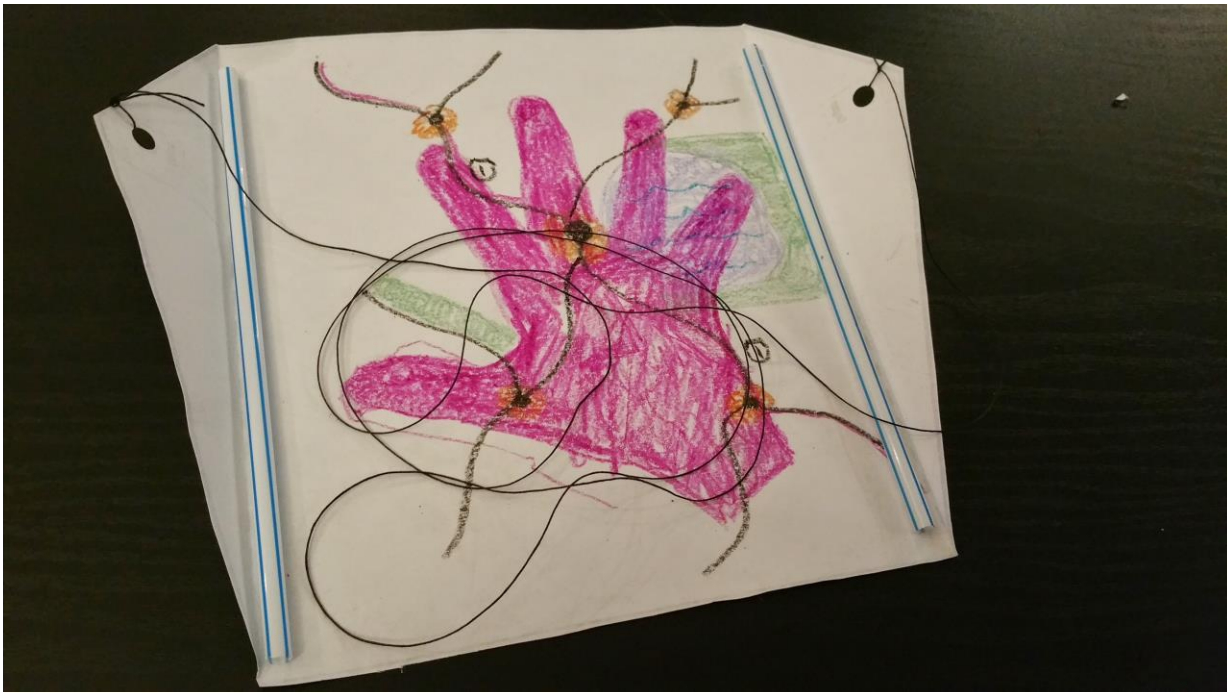


5. After decorating the kite, place tape in the designated spots to reinforce the paper and use a hole punch to make holes on either side of the sled kite.

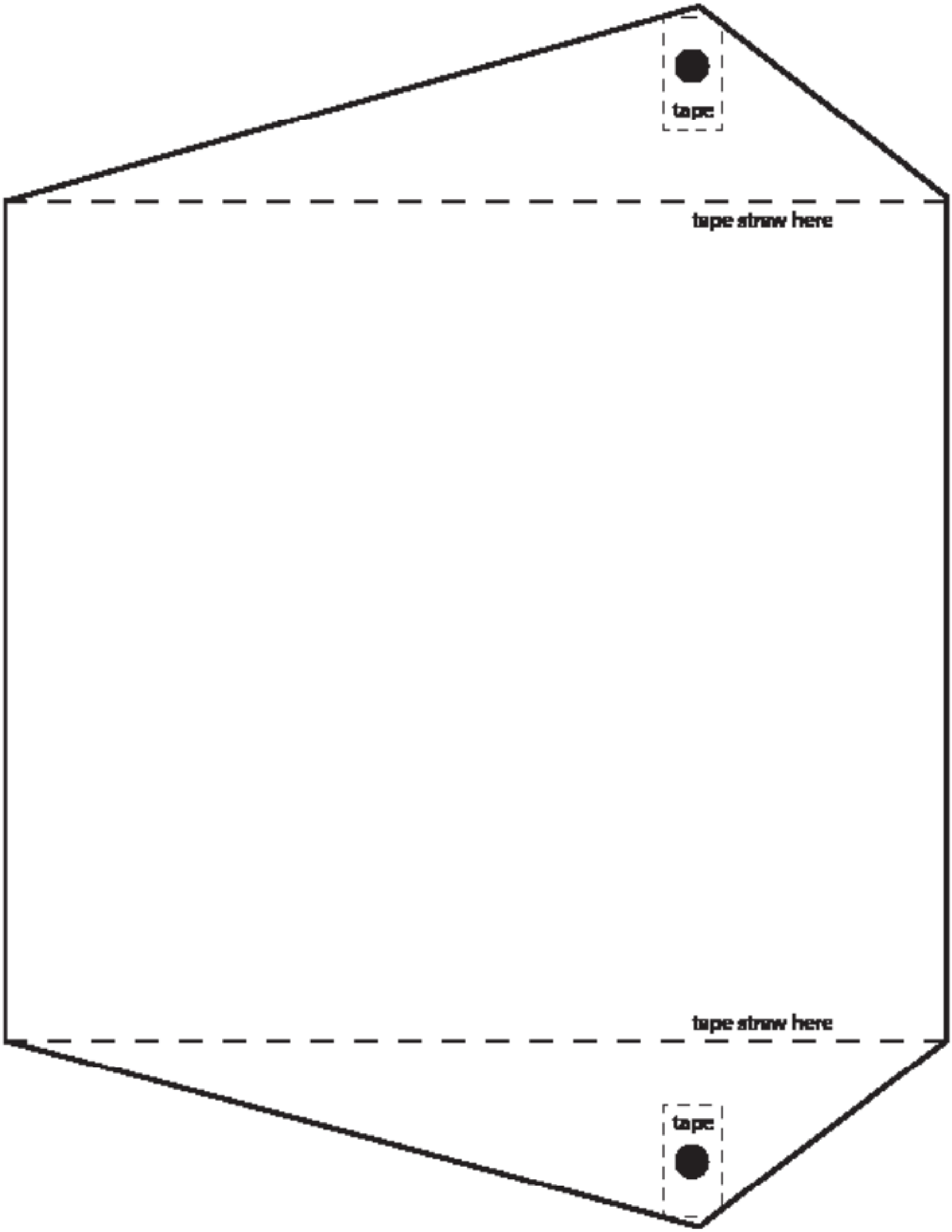
6. Use tape to secure two straws at the appropriate location.

7. Attach 12-inches of string through each of the holes, and attach those two strings to a longer string for kite-flying.



8. Allow students to try flying their kite using a constant breeze or even a fan.

9. Encourage students to try making different sized kites to compare their lift ability and stability. A number of simple sled kite kits can be purchased online.


tape
tape straw here
tape straw here
tape

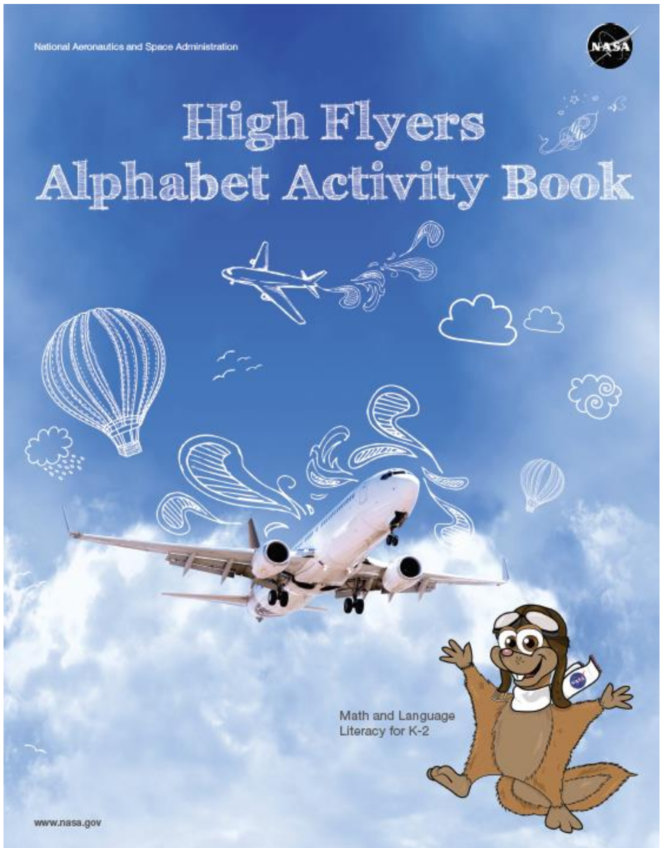
Art Project: Suncatcher

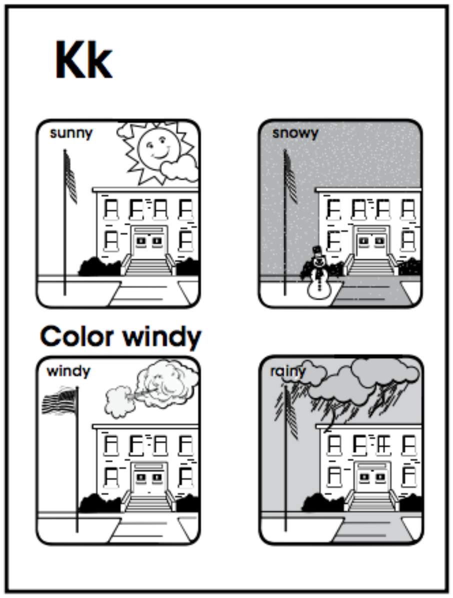
Design a kite suncatcher. Allow children to practice cutting tissue paper to make kite suncatchers. The flat bits of tissue paper can be placed between two pieces of wax paper, and quickly heated with an iron until they are melted together (do not overheat, or the wax will no longer stick).

The suncatcher can then be affixed to a window for a beautiful display of colors.

Writing: "K"

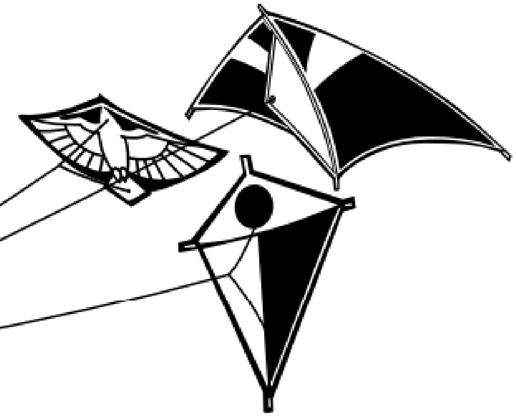
Practice writing the letter K using the NASA High Flyers Alphabet Activity Book.



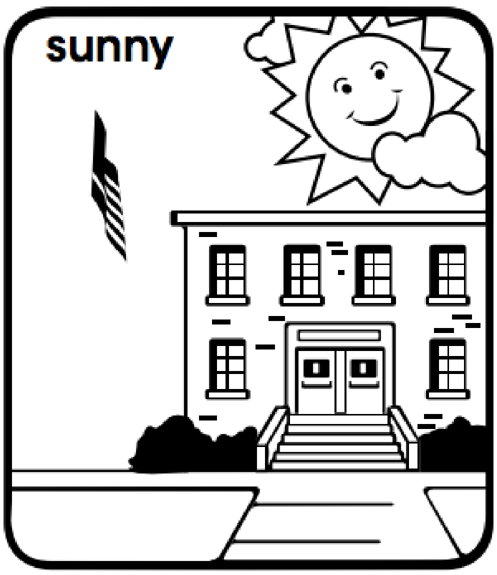


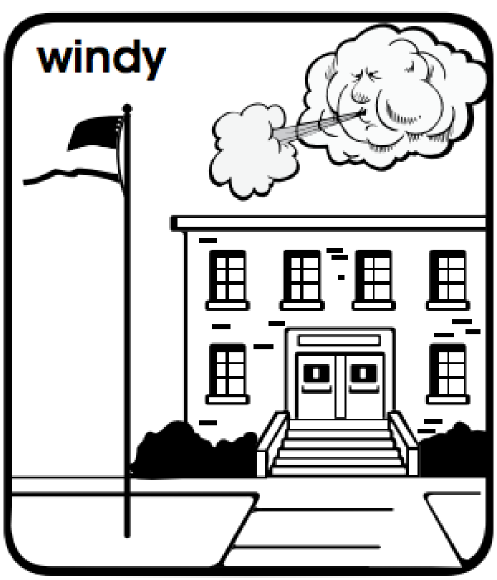
Kk

kite



Color which type of day would be best for flying a **kite**.





Lesson 5

Helicopters and Airplanes

Key Q's
What is the difference between a helicopter and an airplane? What is the difference between a glider and an airplane? What is thrust?

Materials
Model airplane
Audio source (for playing song)
Fan/hair dryer
Pie pan
Pencils
Notecards
Glue
Tape
Wood (6" x 12")
Large nails (2)
Hammer
Rubber band
Paper clips
Printer Paper
Rubber band airplane
Plastic whirly-bird (optional)
RC helicopter (optional)

Resources
High Flyers e-Book

Lesson 5: Helicopters and Airplanes

Helicopters and airplanes provide young children with the opportunity to conceptually synthesize what they learned about in previous lessons with the addition of thrust as one of the four forces of flight (lift, weight, thrust, drag). In this module, children read about airplane flight and the construction of aircraft in *Clorinda Takes Flight*. Afterward, children participate in a movement-based song and then construct paper airplanes to look at the effect of surface area and mass on flight distance.

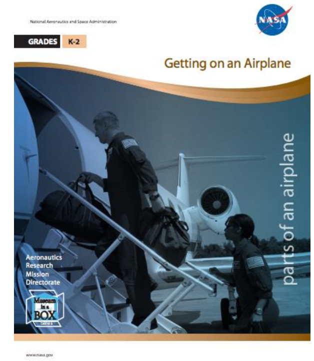
Focus Storybook

Clorinda Takes Flight
Cover and illustrations from CLORINDA TAKES FLIGHT by Robert Kinerk, illustrations by Steven Kellog

Learning Goals

Language	• Vocabulary: airplane, helicopter. • Writing: Practice writing the letters “A,” “H,” and “Z.”
Math	• Use visual guidance to fold a glider. • Measure the distance flown by a glider.
Science/Engineering	• Design and launch a glider. • Compare how wing area affects the distance flown by a glider.

Science/Engineering: Pre-Reading Activities



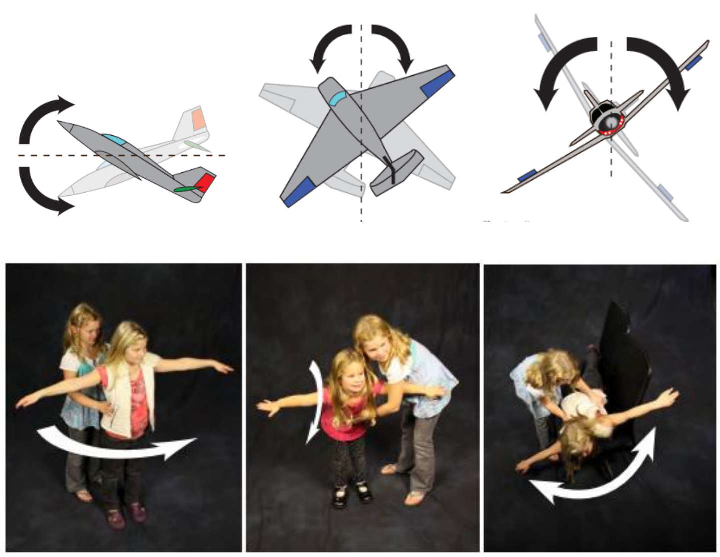
“Getting On an Airplane”

Download from NASA’s Museum in a Box “Getting on an Airplane” lesson.

Begin the lesson by listening to the “Getting On an Airplane” song, and encouraging children to sing along to the chorus.

Before listening to the song again, have children pretend to be airplanes. Ask them to move around the room as if they were airplanes. Carefully observe their moments for examples of pitch, yaw, and roll.

When a good example of pitch, yaw, or roll is observed, ask the children to freeze. Ask the child using the appropriate motion to demonstration his/her motion to the rest of the children while the teacher explains what the movement is called. Have all children practice pitch, yaw, and roll, and explain how the motion affects flight.



Technical Term	Airplane Movement	Use of Airplane Part
Pitch	The nose of the airplane slants up or down.	Pilots use the elevators on the vertical stabilizers to control pitch.
Yaw	The nose of the airplane moves side to side on the horizontal axis.	Pilots use the rudder on the horizontal stabilizer to control yaw.
Roll	The entire airplane tilts to the left or the right.	Pilots use the ailerons to control roll.

Verbal instructions for each movement can be found below:

Airplane Movement	Body Movement (from airplane pose)
Pitch	Have each student stand with their arms outstretched, pretending they are wings. Next, have them bend forwards and backwards at the waist while keeping their head upright. This demonstrates the effect the elevator has on the airplane.
Yaw	Have one student in each pair (Student A) stand with his or her arms outstretched, representing wings. Have the other student in the pair (Student B) place his or her hands on Student A's waist. Now, have Student B twist student A around the waist. This demonstrates the effect the rudder has on the airplane.
Roll	Place both students' chairs together so that Student A can lay face down on them, again with his or her arms outstretched.Have Student B hold the arms of Student A, rolling them from side to side on the chair. This demonstrates the effect ailerons have on an airplane.

Before listening to the song again, teach children some motions to the song lyrics:

Song lyrics: "I'm getting on an airplane" – children march
Song lyrics: "How does the plane fly?" – children tap finger to chin with questioning look
Song lyrics: "There are many parts to an airplane" – children use right index finger to point in front of them, bouncing finger in the air from right to left
Song lyrics: "To keep it moving through the sky" – children place arms in wing positions, tilting up and down
Song lyrics: "It carries people and cargo" – put one hand out in front of body, slightly cupped, then with the other hand do the same
Song lyrics: "The pilot sits in the cockpit…" – pretend to grip steering wheel

Interactive Demonstration: Gliders, Planes, and Helicopters

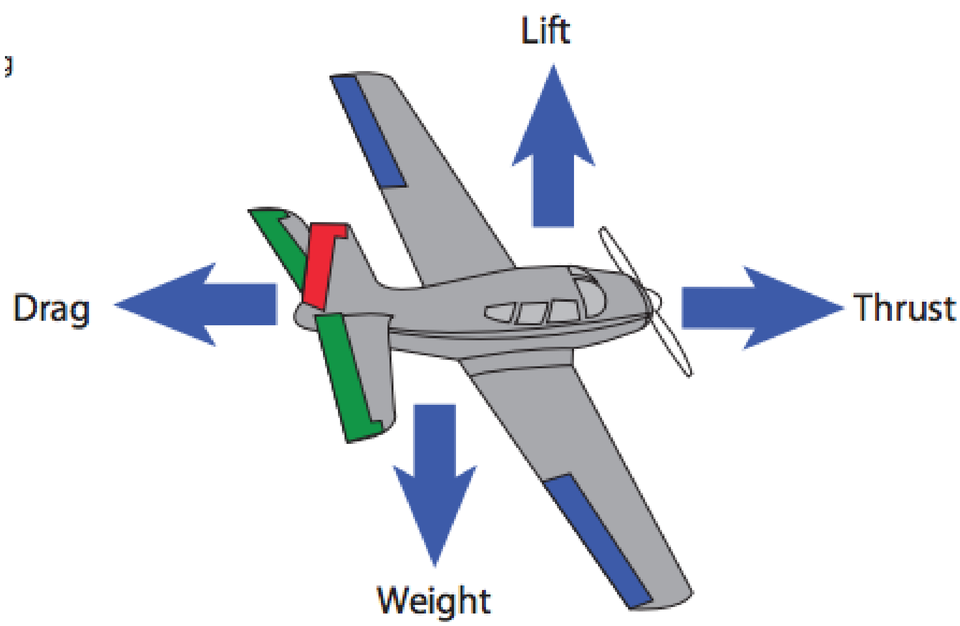
Show students the following items:

1. Paper "airplane"
2. Rubber-band airplane
3. Plastic whirlygig OR remote-control helicopter

Ask students what they view as the differences between each of these objects:

Children should notice the following:
1. A paper airplane does not have a propeller (as a result, it is actually a glider, not an airplane).
2. The rubber-band airplane has a propeller (however, some airplanes have jet engines in place of propellers).
3. Helicopters have propellers, but they face up to generate lift, instead of forward on an airplane.

Help children to understand that airplanes have propellers (or jet engines) *and* wings. Propellers generate thrust on an airplane, while the wings generate lift.



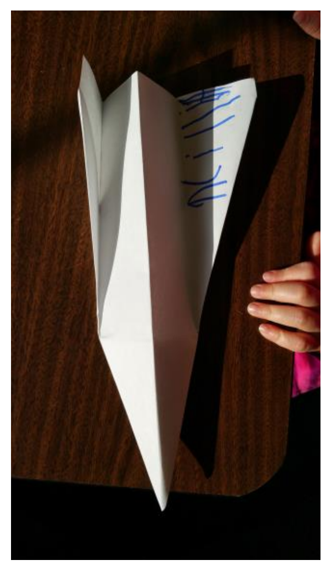
Science/Engineering: Pre-Reading Activities

Inquiry Experiment: Surface Area and Lift

Good airplanes also tend to be good gliders. Based upon their experiences building a variety of gliders, ask children to think about what might make a good airplane. To help them see that "size" (surface area) makes a difference, have them hold two prepared pencils mounted with two postcards. Children should feel a real difference in lift, as evidenced by how far up each pencil goes before stabilizing.

Alternatively, simply ask students to hold the edge of a pie pan between their thumb and forefinger, and ask them to observe what happens to the pan when held in front of the fan. If possible, change the speed of the fan, then ask students to explain what happens to the amount of lift experienced by the pan when the air is moving more slowly or quickly. (In turn, the use of propellers on airplanes allow the plane to move faster with respect to the wind, so it generates more lift!)

Inquiry Experiment: Surface Area, Thrust, Angle, and Distance



Demonstrate and have children fold a paper airplane. Remind children that it is actually a glider, because it does not have any propellers or engines. The only thrust the paper airplane gets is during its launch phase.

Children can investigate surface area and the effect on lift (measured via the distance it goes) by launching it from an equal-thrust platform. To create paper airplanes of different surface area, consider providing children with pre-folded airplanes *before wings have been folded down.* Allow the children to choose if they want their airplane to have large or small wings. Paperclip together the central portion of the airplane (perpendicular to the ground) and then fold down the corresponding amount of paper for the wings (horizontal to the ground).

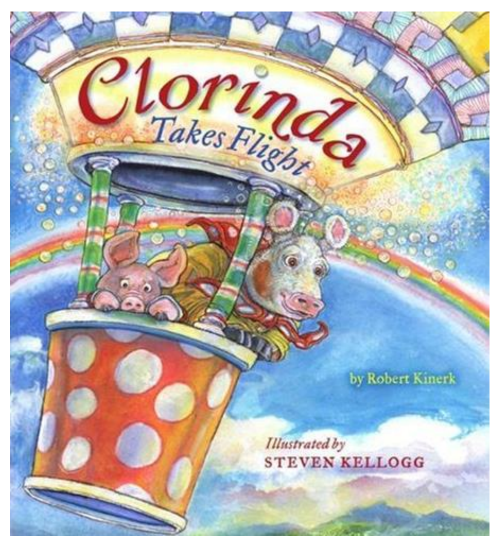
There are many different ways to fold a paper airplane, and a variety of templates can be found online. Children can test their paper airplane by simply throwing them. However, in order to fairly test paper airplanes' distance based upon differences in wing surface area, it is important that they all be launched with the same initial launch force, at the same height, and at the same angle.

Optionally, help children launch their glider from a prepared launch pad (wood, nails, rubber band, paper clips). A paper clip can be easily inserted through a hole in the nose of a paper airplane, and then hooked onto the rubber band and pulled back equal amounts for each launch. Alternatively, paper airplane launchers can be commercially purchased online for a relatively low cost.

If appropriate, have children practice using a measuring tape or counting floor tiles to quantify how far their glider went.

Allow children to change a number of variables – one at a time – to see the net result on the distance traveled. Some variables might include gliders of different surface areas (with the same mass), different amounts of initial thrust (depending upon the distance the rubber band is pulled back from its neutral position), angle (depending upon the angle of the launch pad), and the resulting distance.

Reading: Clorinda Takes Flight



© Robert Kinerk and Steven Kellogg

Read *Clorinda Takes Flight*. Engage children throughout the story by asking them to:

- Identify the types of flying machines built by Clorinda (airplane, helicopter, rocket, hot air balloon).
- Explain the differences between each flying machine. *Airplanes and helicopters use propellers, rockets use fuel, and hot air balloons use the principle of flotation.*
- Help students to consider the engineering process:
    - How many "failures" did Clorinda experience before she was successful? What should you do when something you want to do breaks or fails the first time you try? *Clorinda's airplane crash-landed, her helicopter broke up, and her rocket fizzled out before take-off. Clorinda gives a great example of someone who both tries again and is willing to continually try new ideas until one of them works.*

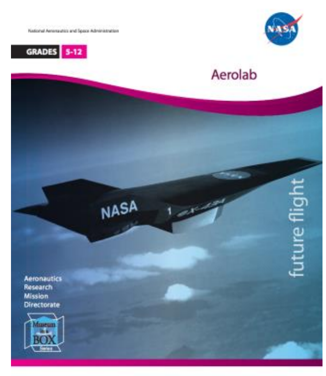
- What was Clorinda's response when she was told by the pig that "Cows can't fly"? *Clorinda refused to give up, and found friends who were willing to support her dreams of flying. She was not afraid of being the first cow to fly!*
- Which of Clorinda's friends supported her efforts?

Science/Engineering: Book-Based Activities

If possible, introduce students to actual airplanes and helicopters that propel their own flight. (Rubber-band airplanes are adequate, and fairly cheap remote-controlled helicopters can be purchased from toy stores or electronic stores.) Ask students:

- How is an airplane different from a glider? (Airplanes propel themselves throughout their flight, while gliders only get pushed initially. Paper airplanes are actually gliders, not airplanes!)
- How is an airplane different from a helicopter? (Airplanes have propellers in the front to pull themselves forward, while helicopters have their main propellers mounted on top to pull them primarily upward.)

If appropriate, allow children to launch rubber-band airplanes and to practice flying a remote-control helicopter. Help students to note that, like real helicopters, remote-control helicopters can be a challenge to control/pilot. Airplane and helicopter pilots must go through a lot of training in order to learn how to safely fly.

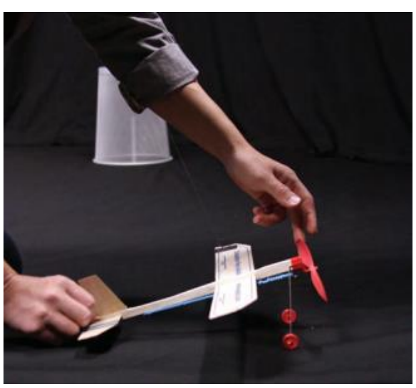


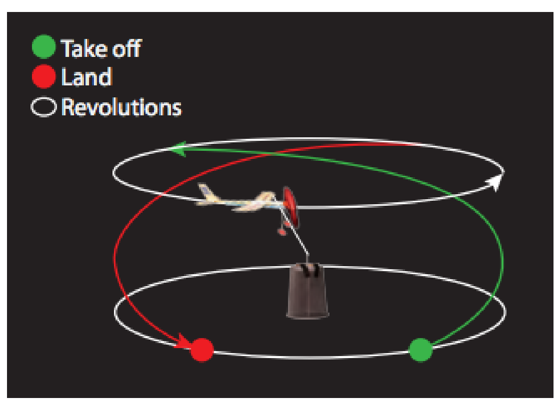
Interactive Demonstration: Aerolab

Use NASA's [Museum in a Box: Aerolab] activity to set up a fun interactive demonstration for students.

The use of a rubber-band airplane can be demonstrated as it flies in a straight line from ground-level in a room.

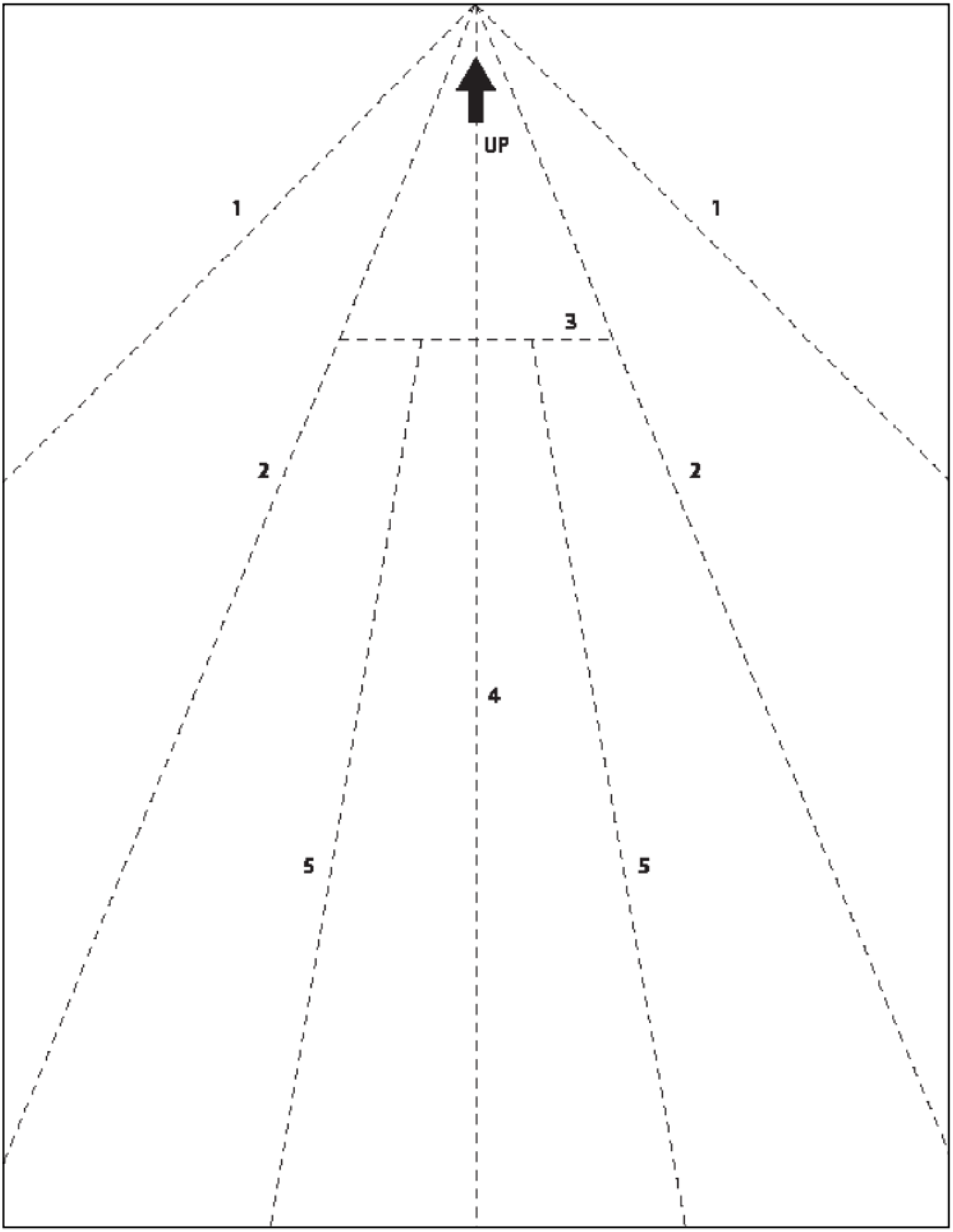
Alternatively, children can observe a rubber-band airplane as it goes in a circle, if it is mounted by a string to a heavy object, such as an inverted trash can.





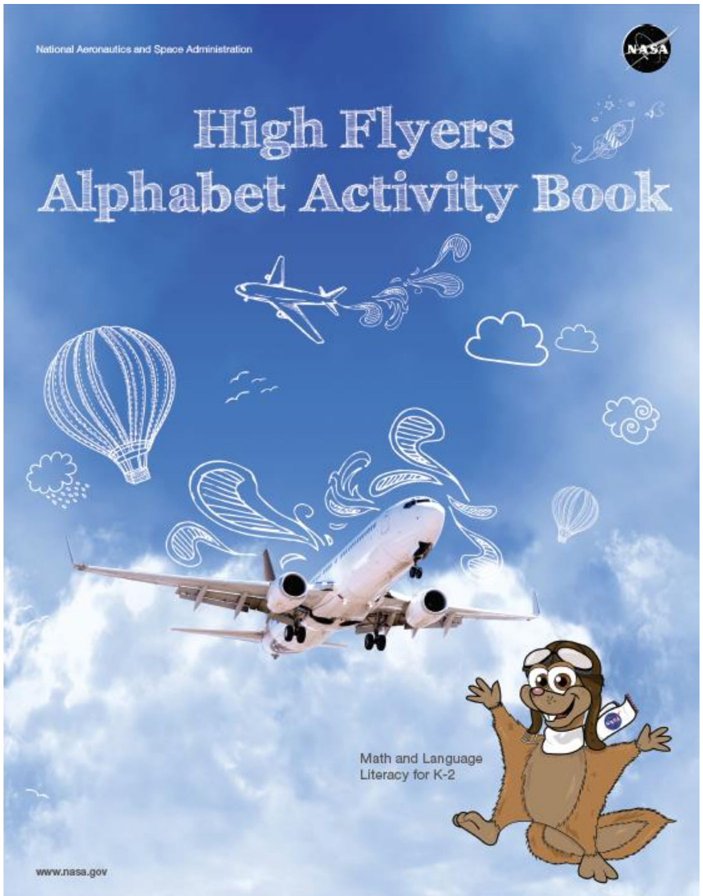
Help children to practice counting the number of revolutions taken by a rubber-band airplane. Ask children to consider what might influence how many times it flies around (a "better" plane will fly further). Consider the following:

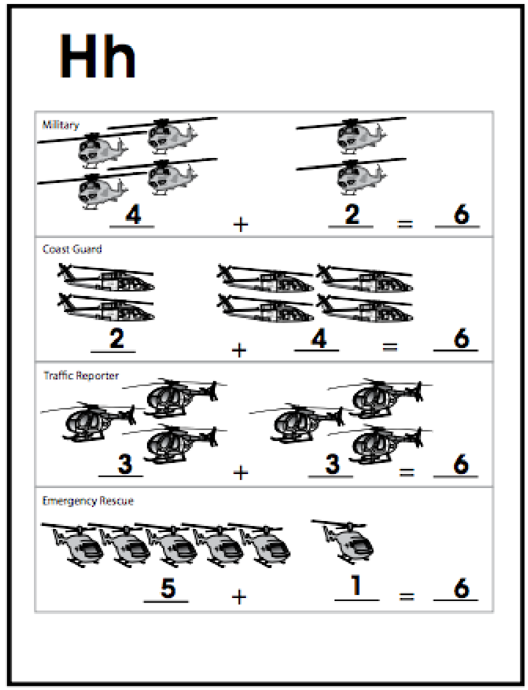
- The number of times the rubber band is twisted before release
- The amount of mass carried by the airplane (tape pennies to the wings)
- The amount of drag on the airplane (tape bits of yarn to the edges of the wings to induce drag)

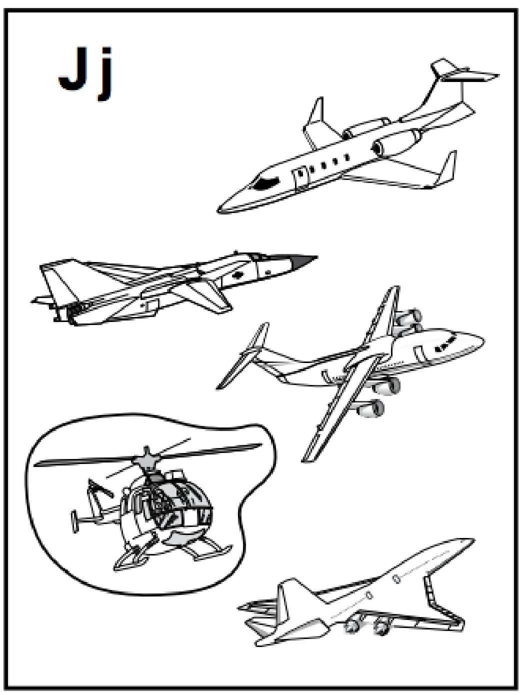

UP
1
1
3
2
2
4
5
5

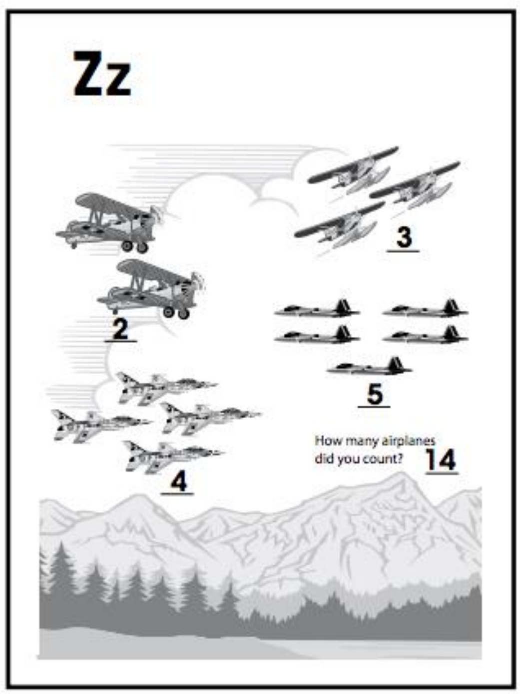
Writing: "H," "J," and "Z."

Practice writing the letters H, J, and Z. Use NASA's High Flyers Alphabet Activity Book.









Hh Hh

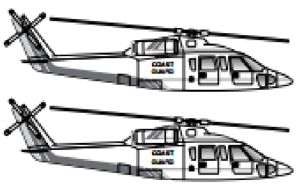
helicopters

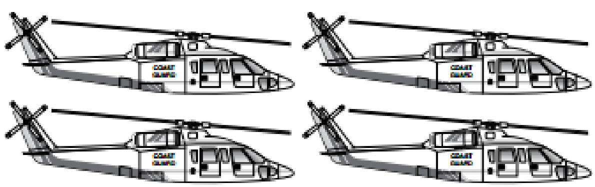
Add the **helicopters** in each group.

Military

_____ + _____ = _____

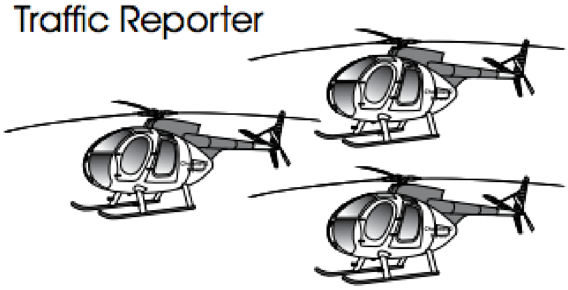
Coast Guard

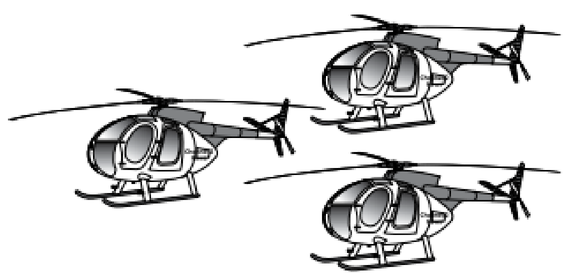




_____ + _____ = _____

Traffic Reporter





_____ + _____ = _____

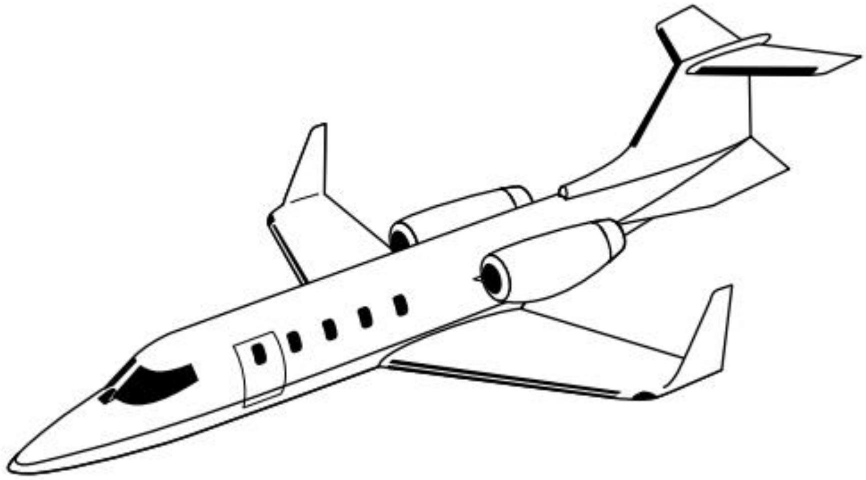
Emergency Rescue

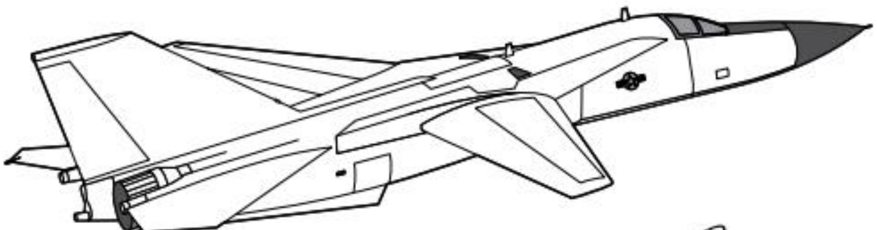
_____ + _____ = _____

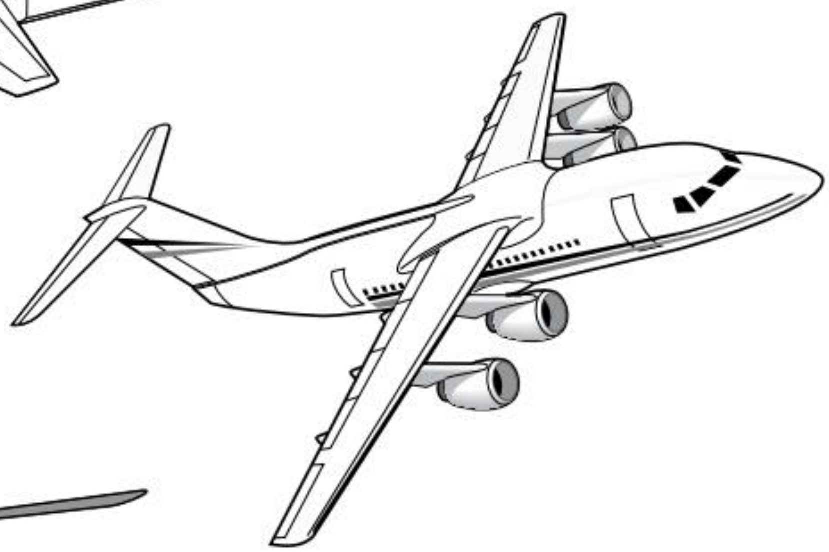
Jj Jj

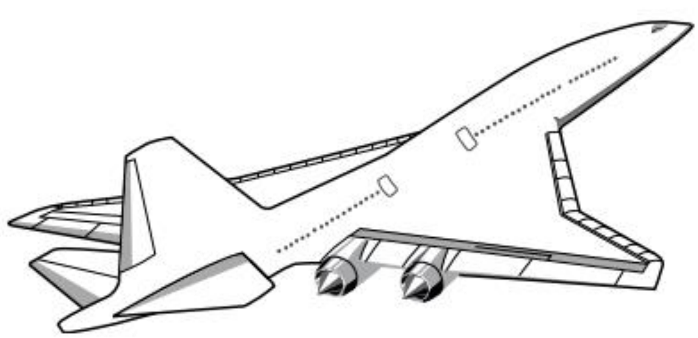
jet

Circle the aircraft that is not a **jet**.





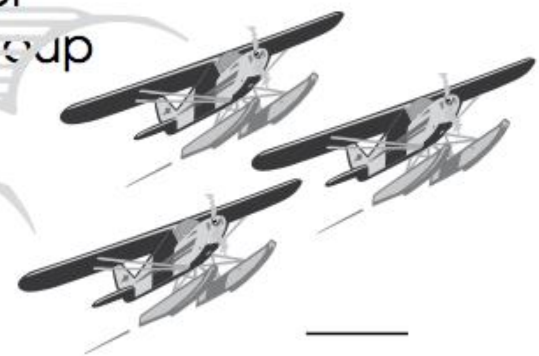




Zz

zoom

Count the number of airplanes in each group as they **zoom!**



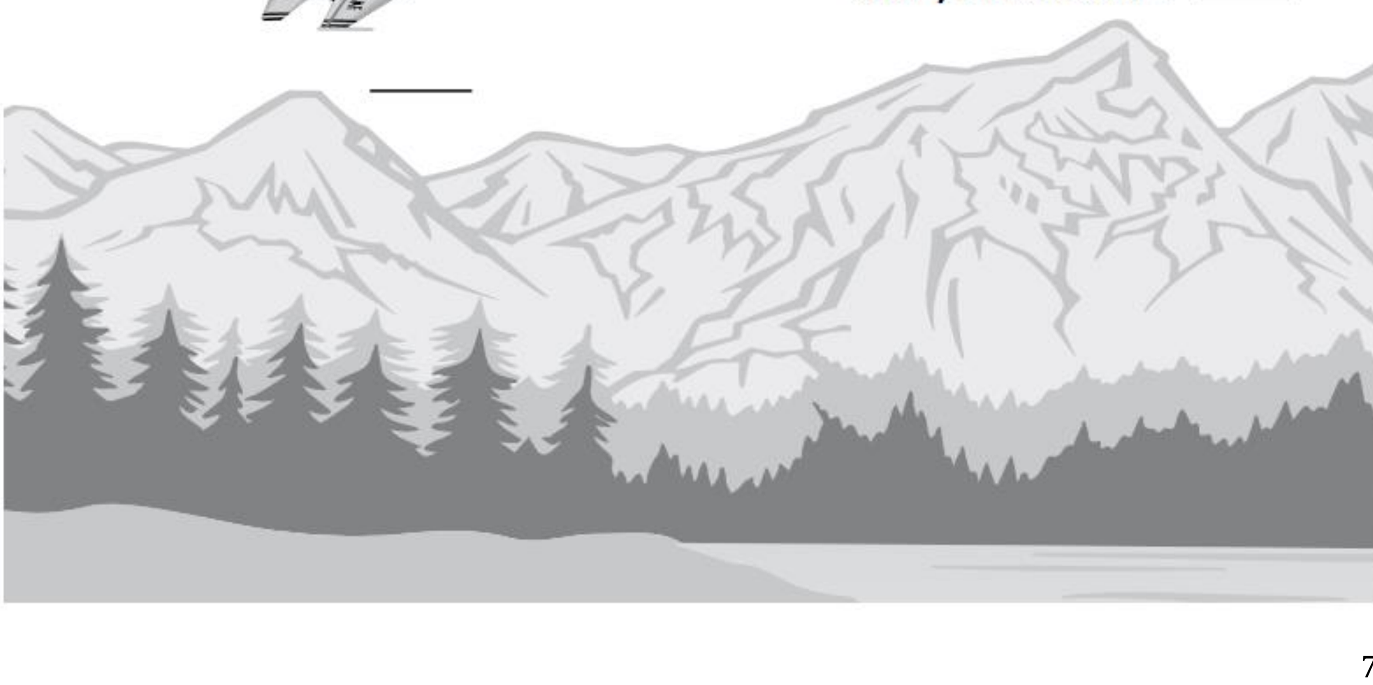
____

____

____

____

How many airplanes did you count? ____



Lesson 6

World Flyers

Lesson 6: World Flyers

Although not all children have flown on an airplane before, this lesson helps students to see that airplanes transport more than just people. The focus story of this lesson is *Planes Fly!*, and it uses simple rhyming to help children understand the segments of a typical passenger flight from check-in and takeoff to landing, as well as the various types of aircraft (jets, fire-fighting planes, and sea planes), and type of cargo carried by planes (live animals and food). While learning about where planes travel, children will learn about geography and map-making with a very conceptual approach to learning Euclidean and spherical geometry.

Key Q's

What is it like to fly in an airplane? What flies on airplanes (besides people)? How do we make maps of the world?

Materials

Items shipped by air cargo (fresh flowers, fresh fruit, empty medicine bottles, foreign souvenirs, etc.)
World map print-out
Beads
Globe
Oranges or other spherical citrus fruit
Map projections sheet

Resources

High Flyers e-Book

Focus Storybook

Planes Fly!

Learning Goals

Language	• Vocabulary: airplane, pilot, and takeoff. • Writing: Practice writing the letters "A," "P," and "T."
Math	• Convert a spherical surface into a flat surface (as in the map-making process) to determine the most accurate type of flat-map projection of the globe.
Science/Engineering	• Identify the seven continents.
Art	• Identify and match the colors of beads to their continents on a color-coded world map. • Make a tissue paper flower to give to a friend.
Fine Motor Skills	• Separate individual tissue papers to fluff up a paper flower.

Reading: Planes Fly!

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Read the story *Planes Fly!* Engage listeners with the following activities:

- Have children share their own experiences of being on an airplane.
- Encourage children to act out some of the scenes, such as putting on their seatbelt, looking out the window, taking a nap, etc.
- Have children identify the USES of airplanes. *Airplanes are often used to carry cargo (commercial items, mail, etc.), to dust crops, to fight fires, and for personal transportation.*
- Have children identify the PRODUCTS that get shipped by air cargo in the story. *In the story, lobsters, horses, and people are all shown being transported by airplanes.*
- Have students work through the "T: Takoff" worksheet provided by the NASA High Flyers Alphabet Activity book after reading *Planes Fly!*

Science/Engineering: Book-Based Activities

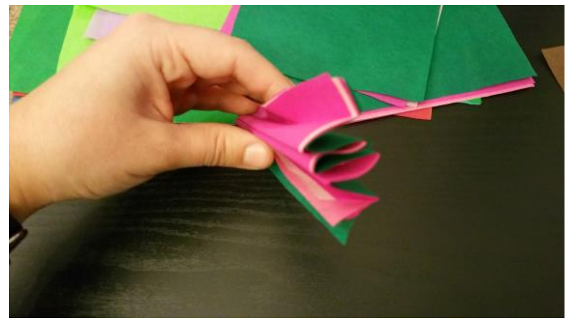
Application Activity: Air Cargo

Airplanes bring us so many things that we could not typically get otherwise, including fresh fruits and flowers out of season, seafood, live animals, medicines, and human organs for transplant, among many other perishable and season-sensitive items. Perhaps most importantly, airplanes bring us closer to people and places we would likely never meet.

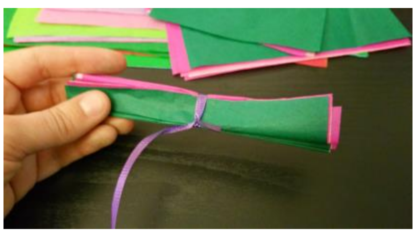
In this activity, children will learn about the many objects that are shipped to us by air, as well as the names and locations of the seven continents.

- Provide each child with a printout of a colorful world map divided up by continent.
- Give each child seven small beads (if possible, in color-coordination of the continents on the map).
- Show each child an object that comes from each continent. If necessary, show images of things that might get shipped by air (see the examples listed below number 2).
- As the object's continent of origin is listed, ask students to place a matching bead on the continent (identify the continent both by its name and its color).
- Allow students to count the number of continents that have beads placed on them after each object is listed.

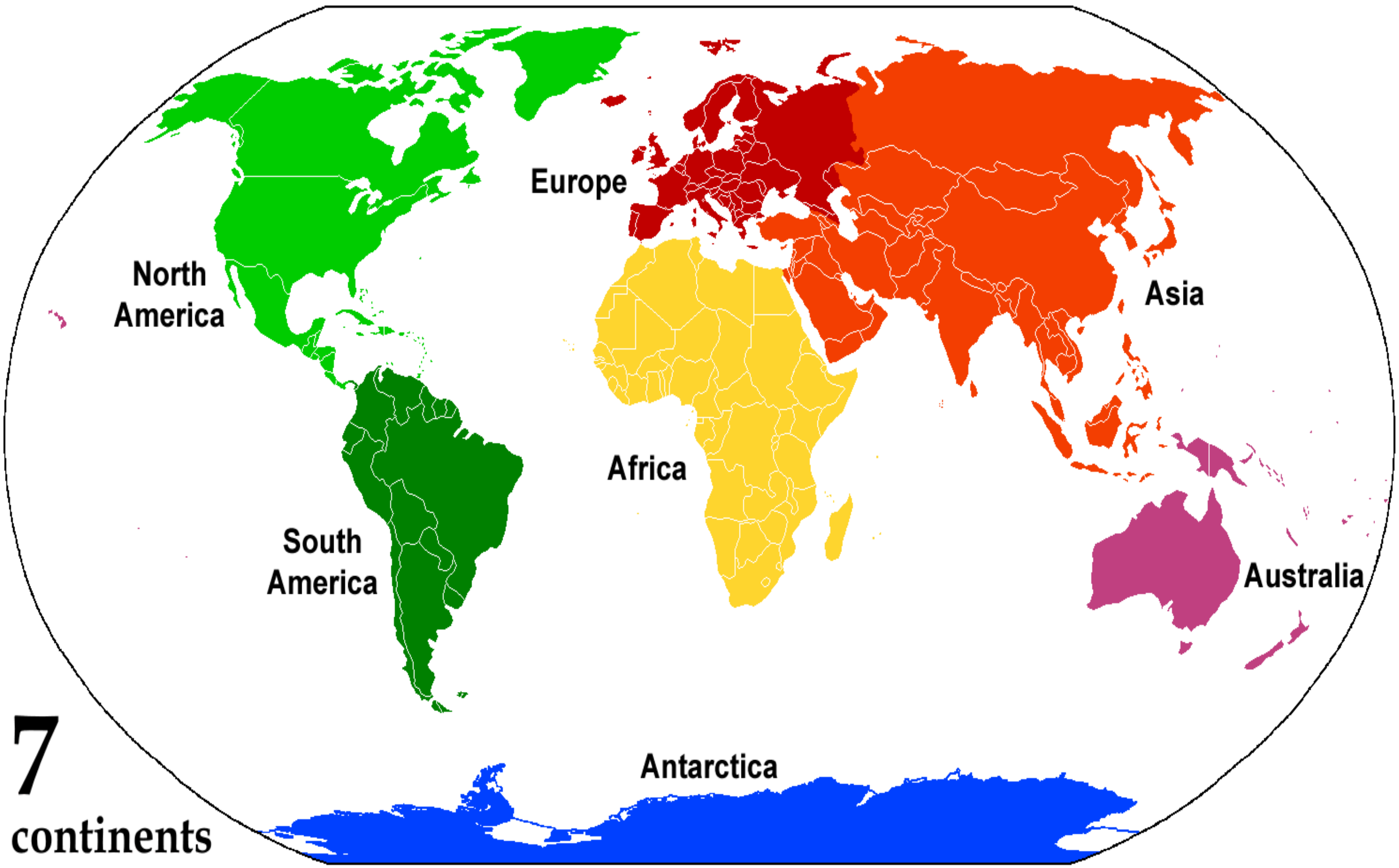
1) Provide each student (or small group of students) with a map of the continents and seven beads or small objects (buttons, etc.).
2) Show students – one at a time – examples of items that have been imported by aircraft. Depending upon the age, ask students to guess where the object came from. Besides souvenirs from international travel, the following are some examples of items that can be displayed:
    a. North America – any U.S.-made items, preferably perishable or time-sensitive items that are likely to have been flown in an aircraft.
    b. South America – fruits/vegetables, coffee, flowers
    c. Europe – chocolates, specialty foods, flowers
    d. Asia – clothing, specialty foods
    e. Africa – diamonds (i.e. wedding bands), flowers
    f. Australia – diamonds
3) As the nation or continent of origin is identified, ask students to identify the continent by placing a bead or small marker object on the map. Help younger students to identify the continents by referring to both the continent name as well as the color of the continent on the map.



4) Flowers are one of the most internationally transported perishable items. Explain to students that they will be making tissue paper flowers to attach to a card that they can give to a friend or family member to help them to share what they learned about the importance of air cargo.
5) Cut out tissue-paper squares that are approximately 4” x 4”. Stack approximately 5-7 tissue paper squares one on top of the other. (If appropriate, prepare these squares in advance).
6) Fold the tissue paper back and forth multiple times in a folded-fan pattern.
7) Use a piece of ribbon to hold the folds together by tying it tightly in the middle.
8) Use scissors to scallop the edges of the folds to give the paper the appearance of petals.
9) Carefully unfold the folds.
10) Delicately separate each tissue paper layer and fluff it up until it has been made into the shape of a flower.
11) Use ribbon to attach the tissue paper flower to a car printed on cardstock.



Flower photo Credit: Tricia Carzoli

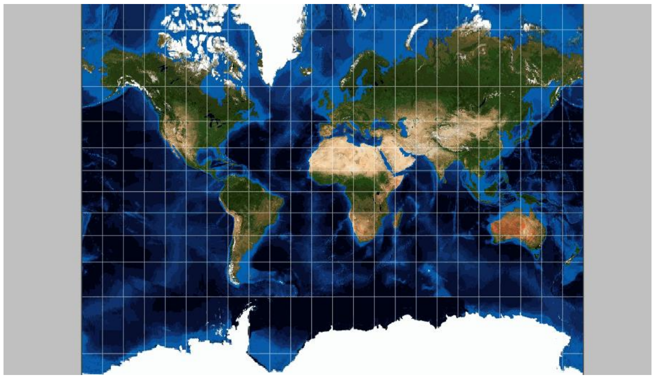


7 continents

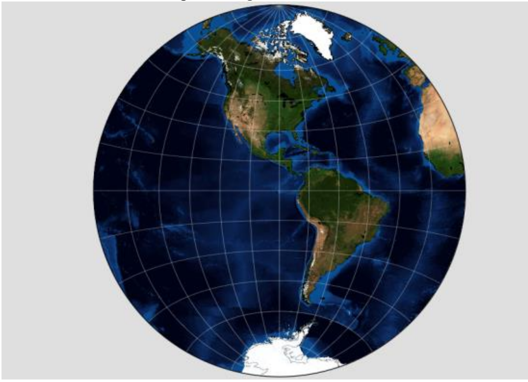
Inquiry Lab: Round Globe, Flat Map

By pre-school age, most children are aware that the Earth is round, like a ball. (If possible, consider providing children with a small globe). However, *maps* of Earth are flat! Show children the following four maps, and ask them which map they think is best to represent the Earth on which we live. *Many children will choose the Airy Projection because it is round, like the globe. However, help them to see that there are some important parts missing (the entire Eastern hemisphere!)*

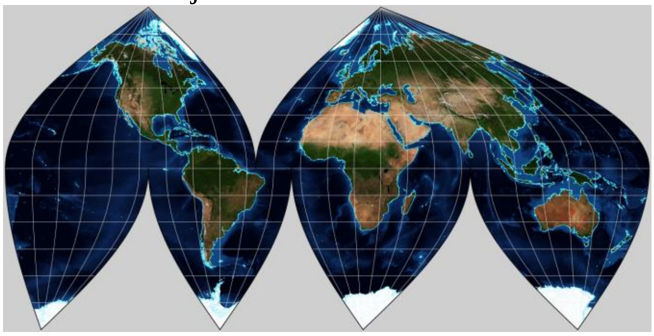
Mercator Projection



Airy Projection



Sinusoidal Projection



Polyconic Projection

1. To find out which type of flat map is actually best for representing the whole spherical Earth, give each student or student group a single orange. (Oranges with thick skins that do not easily tear are best for this activity). Optionally, allow students to draw a map of their design on the orange.

2. Using a butter knife, help students to cut a vertical slit in the orange from the top to the bottom.

3. Ask students to flatten their spherical maps. This can be accomplished by carefully peeling the skin of the orange using a butter knife to make sections. Students should notice that a curved surface cannot be flattened on its own. The orange peel can be carefully flattened, but it is expected that the peel will rip.

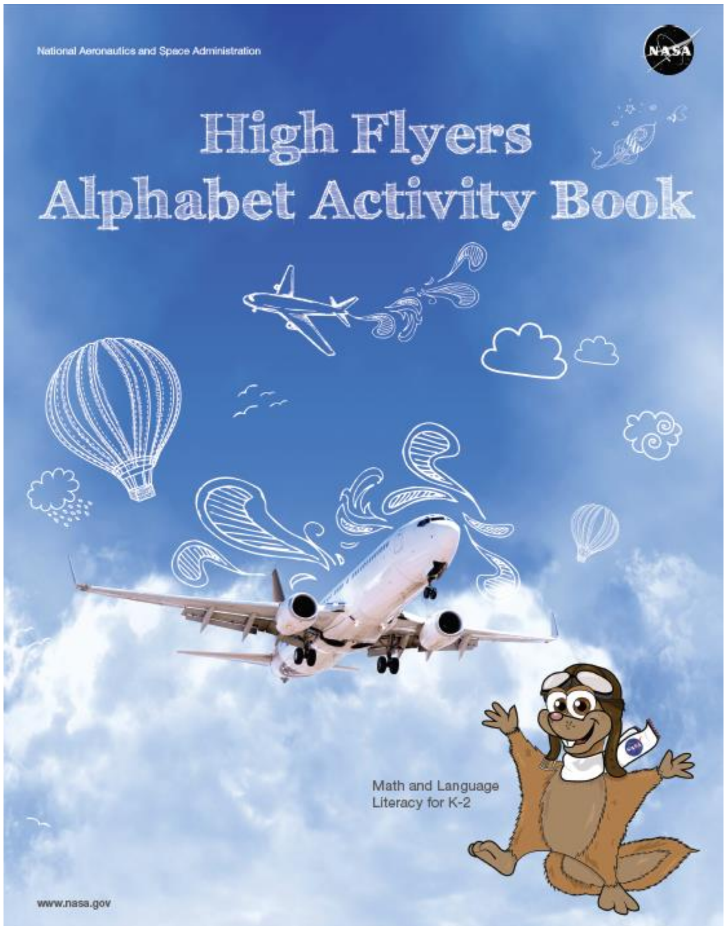
4. Once students have flattened their peels, ask them to notice where most of the cutting or ripping had to occur, and in which direction. Students should find that most of the cuts or rips occurred near the top and bottom ends of the map, going vertically. (Caution: This is not true if the incision in the globe goes along its "equator," rather than across it).

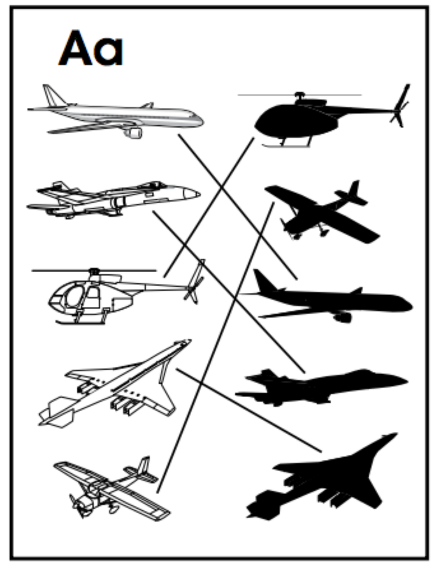
5. Ask students to compare their flattened peels to the maps first introduced to them.

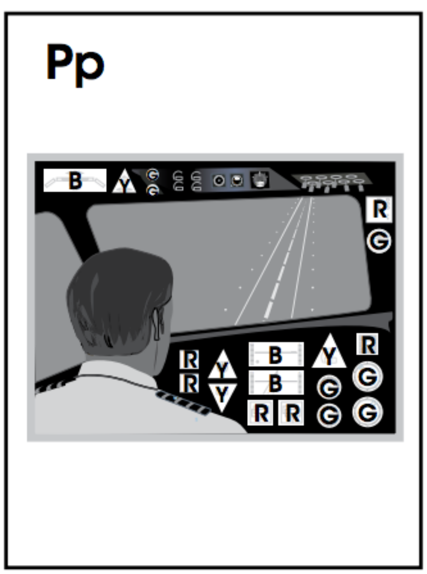
6. Ask students to now choose which map they think is best for representing the spherical globe on a flat map. *Most students will see that the circular map is not at all the best choice, nor, for that matter, the common rectangular map. A sinusoidal map is actually best, because it represents the rips and tears that are experienced by taking a spherical shell and flattening it.*

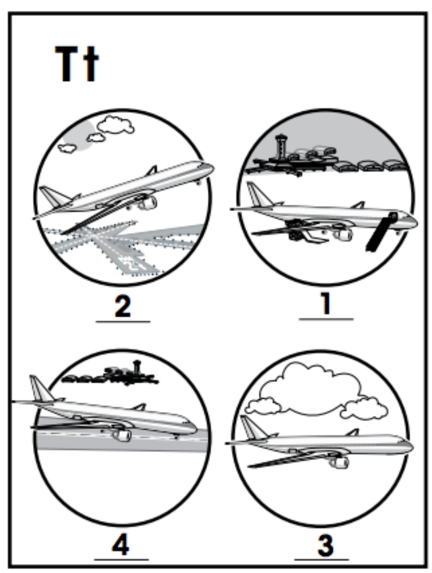
Writing "A," and "P," and "T."

Practice writing the letters A, P, and T. Use NASA's [High Flyers Alphabet Activity Book]().





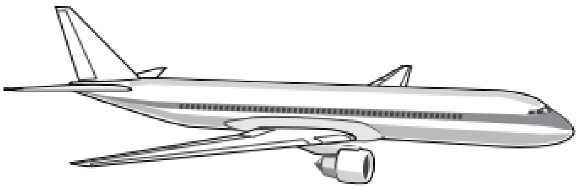
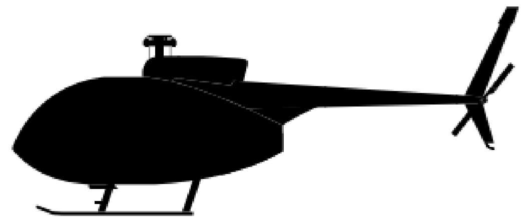
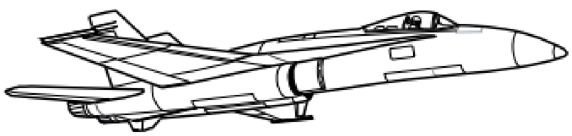


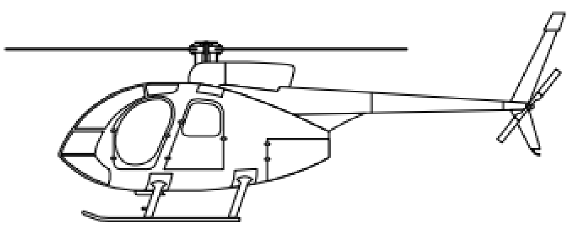
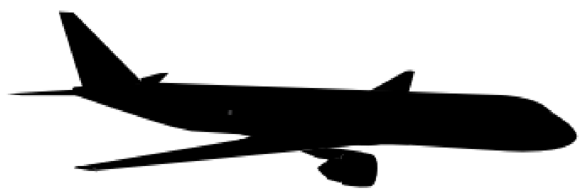
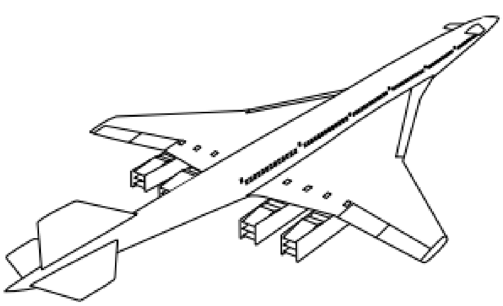


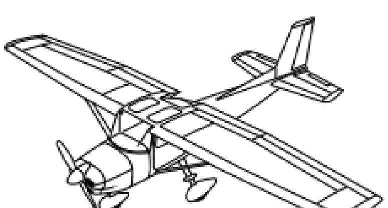
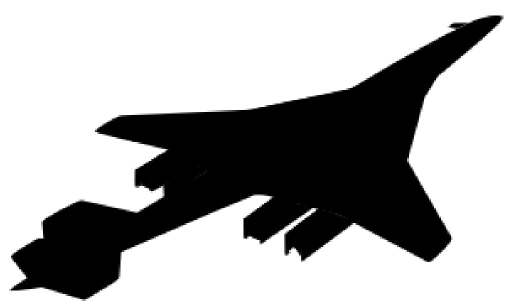
Aa Aa

aircraft

Draw a line to match each **aircraft** to its shadow.

Pp Pp

pilot

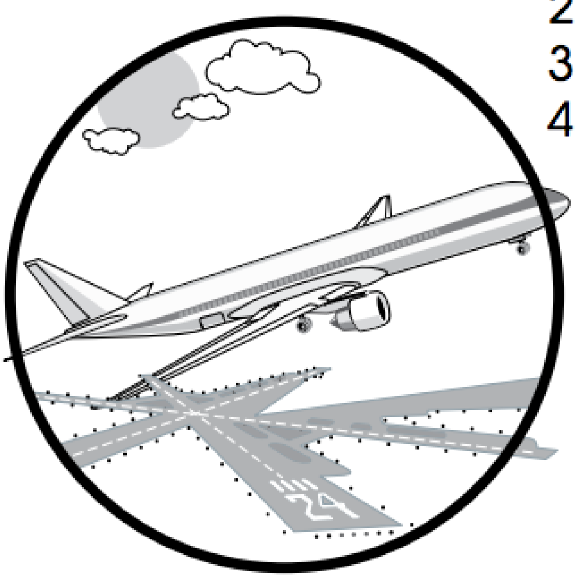
A **pilot** uses instruments in the cockpit to fly. Color the circles green, the squares red, the triangles yellow, and the rectangles blue.

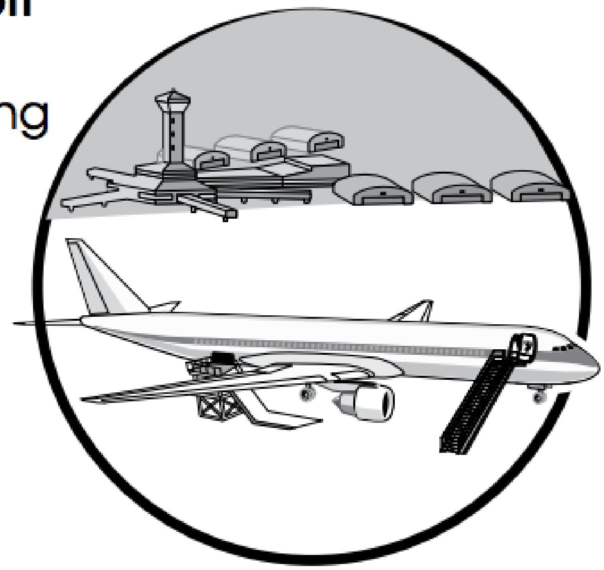
Tt Tt

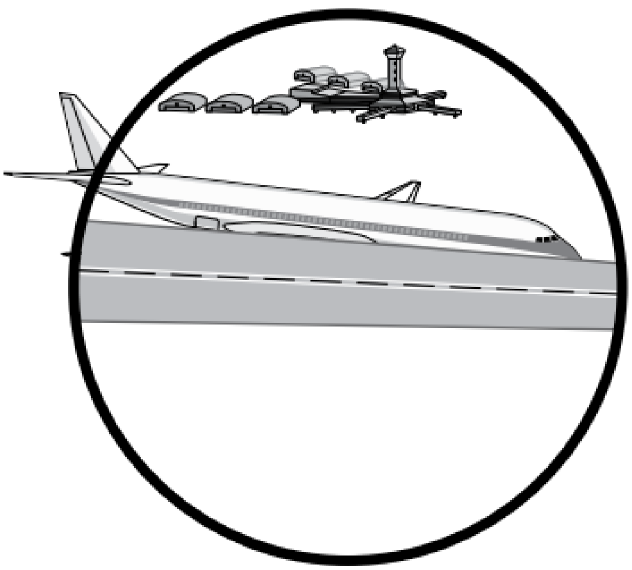
takeoff

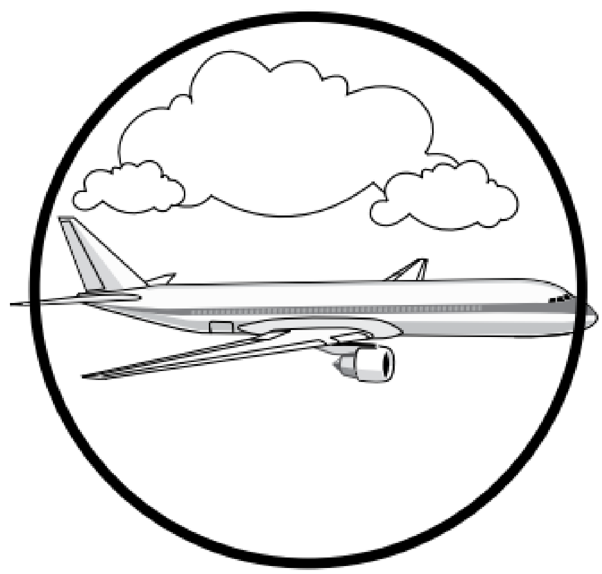
Write the number under the matching picture.

1. Loading
2. **Takeoff**
3. Flying
4. Landing









Additional Information and Educator Resources

Although we often fail to recognize it, aviation has connected us in ways that deeply impact our daily lives. When you fly to your favorite destination, consider the places you can go, things you can learn, and people you can meet. Before the invention of the airplane, you would likely have been unable to travel very far at all in your lifetime. Even if you do not fly, consider the people and ideas that have come to you! Without airplanes, your world and your life experiences would be very limited indeed.

A visit to your common grocery store is now an international experience brought to you by the power of flight. When you walk into a grocery store, take note of the fruits and vegetables available to you year-round and that could otherwise not be grown in your geographic region. Most of these items transited the air cargo system in order to arrive as fresh as possible and still maintain a reasonable shelf life.

Perhaps surprisingly, even the local farmer's market is not immune to the impact of aviation. Locally grown flowers might have been germinated from seeds flown from South America, and the farmers who sustain the market might make a portion of their income from air-shipping some of their produce around the nation or around the world.

Although not all imported or exported products are shipped by air, most perishable items do travel by plane because of the speed of air cargo in comparison to ground- or water-based transportation. When making purchases of produce that is out of season locally, it can be fairly easy to deduce if a fruit or vegetable has been primarily shipped by air, water, or ground transportation, depending both upon the distance from the item's origin as well as how quickly the produce ripens and spoils. For example, berries, cherries, peppers, and asparagus are among some of the most frequently air-shipped produce because of their short shelf life. Dry onions and coffee beans are more likely to be shipped more cheaply by boat or ground because of their weight, durability, and ability to withstand long transport times.

An additional digital children's book with informational commentary for adults about NASA's contributions to aeronautics can be found here:

With You When You Fly
NASA's Educator Resource Guide for
Living in the Age of Airplanes
http://www.nasa.gov/sites/default/files/files/Living-in-the-age-of-airplanes-resource-guide.pdf

To learn more about the beauty of flight, its impact on our lives, and NASA's contributions to aviation, please check out the following resources.

NASA Aeronautics:
http://www.nasa.gov/topics/aeronautics/index

- Aeronautics Education Teacher Resources
  - *Aeronautics for Pre-K* (Pre-K/Early Education)
  - *Museum in a Box* (Elementary – High School)
  - *Aeronautics for Introductory Physics* (High School – Introductory College)
- Lithographs: *NASA's Contributions to Aviation, Parts of an Airplane*
- Videos, News, Updates
- App: *Sector 33* air traffic control game
- e-Books

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