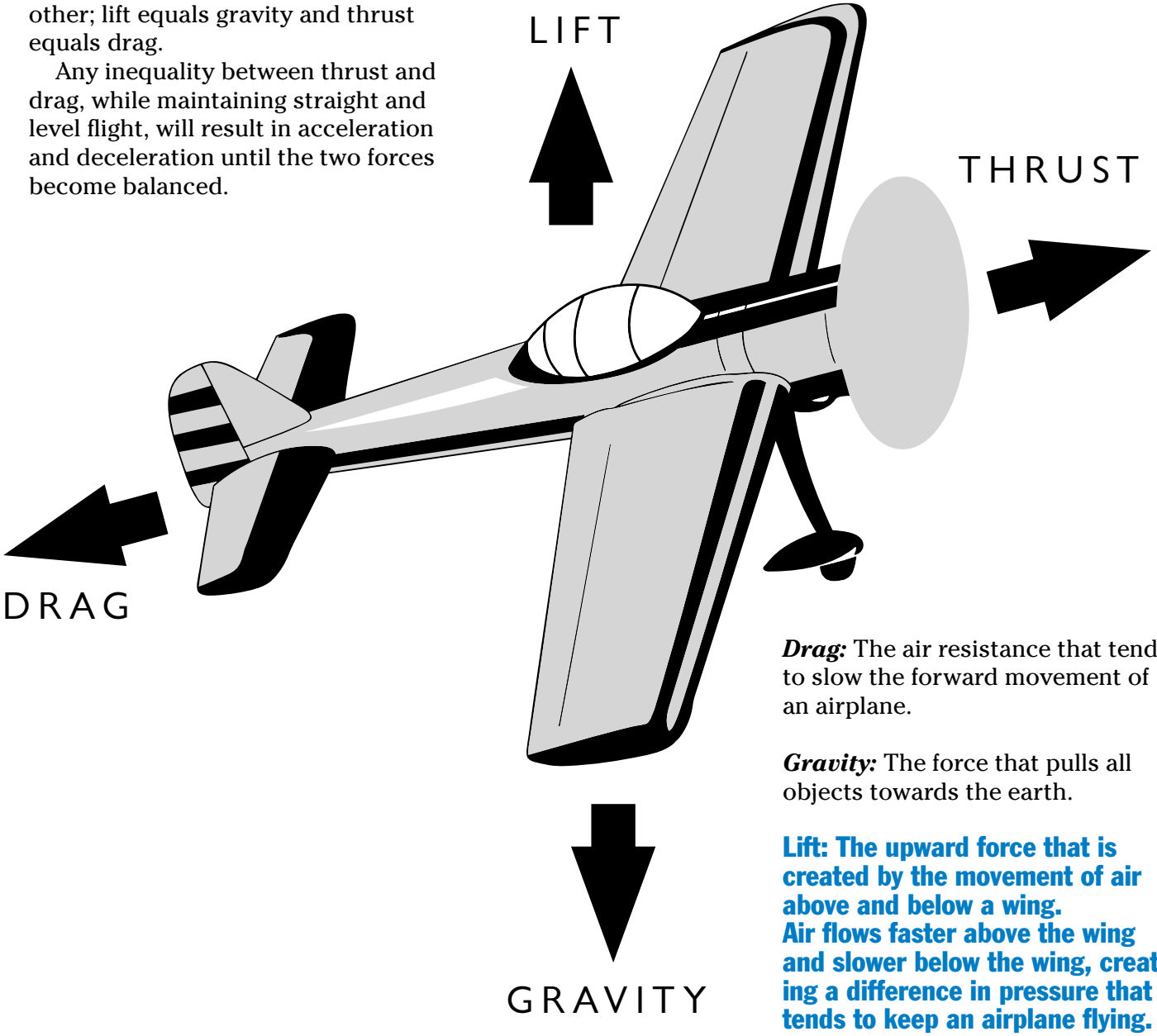
THE FOUR FORCES OF FLIGHT–LIFT

An aircraft in straight and level flight is acted upon by four forces: ***lift, gravity, thrust,*** and ***drag.***

The opposing forces balance each other; lift equals gravity and thrust equals drag.

Any inequality between thrust and drag, while maintaining straight and level flight, will result in acceleration and deceleration until the two forces become balanced.



Drag: The air resistance that tends to slow the forward movement of an airplane.

Gravity: The force that pulls all objects towards the earth.

Lift: The upward force that is created by the movement of air above and below a wing. Air flows faster above the wing and slower below the wing, creating a difference in pressure that tends to keep an airplane flying.

Thrust: The force that moves a plane forward through the air. Thrust is created by a propeller or a jet engine.

LIFT

Uplifting Adventure

OBJECTIVE:

Instigate the principle of lift.

PROBLEM:

How does the design of the airplane affect the lift?

MATERIALS:

several 8-1/2 x 11" sheets of papers for each student, a stopwatch,
and one copy each of two “Pilot Log Flight Data Sheet” Blacklines for each pair.

BACKGROUND INFORMATION:

Lift is created by the shape of the wing, which makes the air pressure
above the plane’s wing less than the pressure below.
This causes the plane to lift forward.
When the lift is greater than gravity, the plane goes up.

MANAGEMENT:

1. 45-60 minutes

2. Students work in pairs. While one student pilots plane, the other times the flight.

3. This activity works best outdoors or in a large indoor area.

WORD BANK:

lift, descent, ascent, landing, aloft, design, fuselage, wing, nose, elevators, rudder

Uplifting Adventure

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PROCEDURE:

1. Each pair constructs the two different designs of airplanes.
(See Blacklines 3 and 4)

2. One pilot will fly his or her design at the timer's signal.

3. The timer starts at release and stops at landing.

4. Each trial is recorded on the Pilot's Logs, Blacklines 1a and 1b.

5. This procedure is completed five times for each plane.

6. Complete the Flight Data Sheet, Blacklines 1a and 1b.

7. Share and discuss the results.
Calculate the class average for each design.

8. Have students create a graph on Blackline 2 using this class data.

Uplifting Adventure

DISCUSSION:

1. How does the design of the airplane affect the lift?

2. What features of the plane kept it aloft the longest?

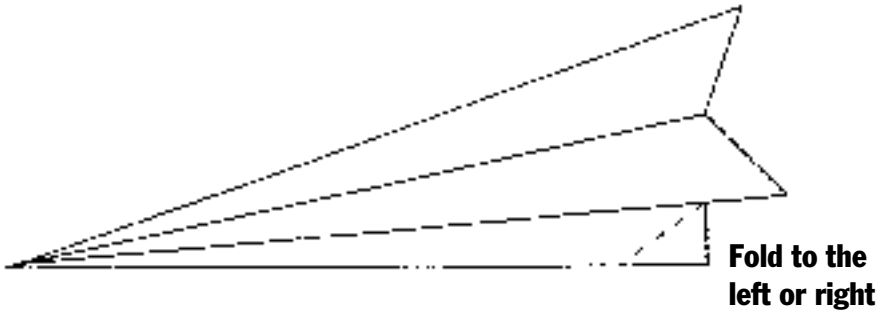
3. What features of the plane kept the plane from staying aloft?

4. How does this activity show how a plane stays aloft?

EXTENSIONS:

1. Students can add elevators to their planes and observe changes in flight.

2. Students can add rudders by folding the base of the fuselage.



CULMINATING ACTIVITY:

Challenge students to design an airplane that will remain aloft the longest.

LIFT 

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PILOT LOG FLIGHT DATA SHEET

Captains:

_____

PREDICTION:

We think plane number _____ will stay aloft the longest.

Here are our reasons:

_____

_____

AIRPLANE #1	
FLIGHT #	TIME ALOFT
1	
2	
3	
4	
5	

AVERAGE TIME ALOFT: _____

LIFT

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PILOT LOG FLIGHT DATA SHEET

Captains:

_____

AIRPLANE #2	
FLIGHT #	TIME ALOFT
1	
2	
3	
4	
5	

AVERAGE TIME ALOFT: _____

1. Which plane had the highest average time aloft?

_____

2. What features of the plane lead to longer time aloft?

_____

_____

LIFT

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CLASS GRAPH

Captains:

_____

Title:

_____

AVERAGE TIME ALOFT (IN SECONDS)

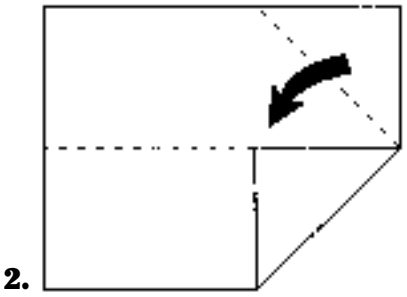
AIRPLANE #1 AIRPLANE #2

Uplifting Adventure

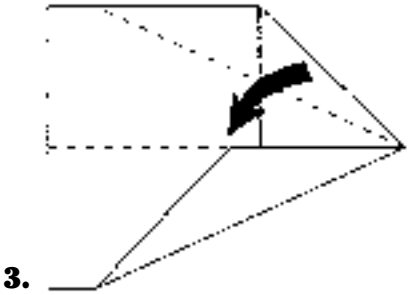
PAPER AIRPLANE MODEL #1

1. Take an 8-1/2 x 11" sheet of paper, fold it in half lengthwise and open it flat again.

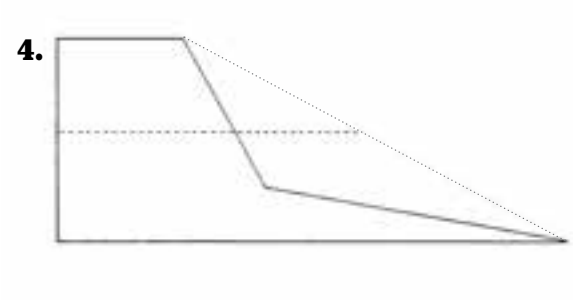
2. Fold the top two corners to the centerline.

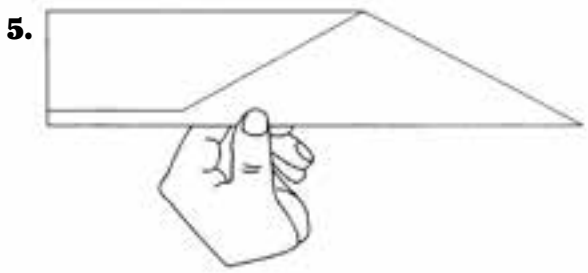


3. In the same manner, fold the corners again to the centerline.



4. Fold back the side along the original fold line, plain sides together. Fold down the sides half way down the wing.





5. Hold the plane underneath and launch with forward thrust.

Uplifting Adventure

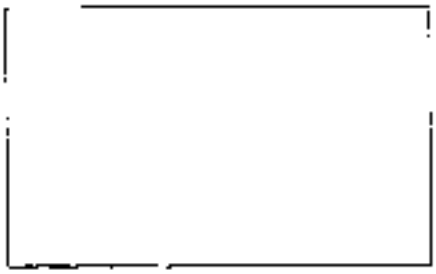
PAPER AIRPLANE MODEL #2

1. Fold an 8-1/2 x 11” piece of paper lengthwise and open it.

2. Fold the bottom edge to the middle crease. Fold it again making four thicknesses.

3. Crease the folded part at its mid-point, causing a slight angle in the wing.

4. Hold at the back of the wing and launch with a gentle forward thrust.



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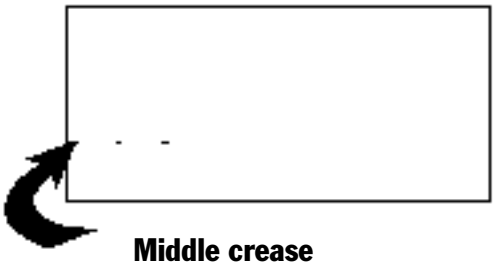

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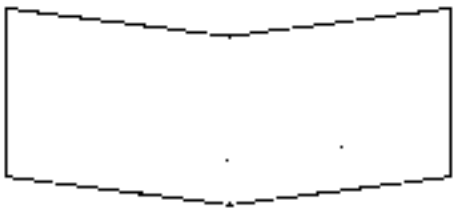

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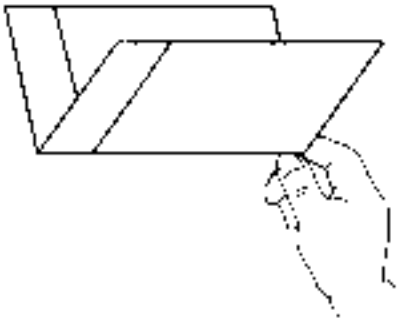

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Fearless Flyers

OBJECTIVE:

Investigate the principle of lift.

PROBLEM:

How does the design of an airplane affect its ability to perform stunts?

MATERIALS:

several sheets of 8-1/2 x 11" paper, scotch tape, design pattern Blackline 1 for each student

BACKGROUND INFORMATION:

This activity uses Bernoulli's principle of lift.
The shape of a wing (airfoil) causes air to move faster over the top of the wing.
The faster the air moves, the less the air presses down on the wing. This creates lift.

MANAGEMENT:

1. 60 minutes

2. Divide class into small groups (3-4 students).

3. This activity requires a large open space.

WORD BANK:

lift, thrust, gravity, drag, climb, bank, loop, boomerang, design, stunt, aerobatics, dive

Fearless Flyers

PROCEDURE:

1. Hand out the Fearless Flyers Data Sheet to each group.

2. Have the teams work together to design planes that will successfully perform the specified stunts on the Data Sheet, Blackline 1.

3. Individually, students draw diagrams of an airplane that completed a stunt and answer the questions on the design sheet (Blackline 2). Students do not have to write about their own plane.

DISCUSSION QUESTIONS:

1. How does the design of an airplane affect its ability to perform stunts?

2. Was there more than one design that could complete the same stunt?

3. Which design was affected most by gravity? Drag?

4. Did the amount of thrust affect the way your airplanes flew?

5. What happens when drag becomes greater than the lift?

EXTENSIONS:

1. Add weight (paperclip) to different points on the fuselage. Observe and discuss the results.

2. Vary the size and weight of the paper.

CULMINATING ACTIVITY:

Each group performs their stunts for the rest of the class.

LIFT

Fearless Flyers

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DATA SHEET

Stunt Pilots:

_____

_____

Can your team design planes that will perform the following stunts?

	AFFIRMATIVE	NEGATIVE
FLY STRAIGHT		
DIVE		
BANK LEFT		
BANK RIGHT		
CLIMB		
BOOMERANG		
LOOP		
DOUBLE LOOP		

DESIGN SHEET

Stunt Design Engineer: _____

StuntPerformed:_____

How did your team design the airplane to perform this stunt?

_____

_____

Why do you think this design cause the airplane to perform he stunt?

_____

_____

Draw and label a diagram of the stunt plane performing its stunt.

Plane name:

_____

Loop Ad-venn-tures

OBJECTIVE:

Compare two designs of loop airplanes, observing the four forces of flight.

PROBLEM:

How are loop-planes and tube-planes similar and different? (design, flight patterns, etc.)

MATERIALS:

one straw, design patterns, Blacklines 1 and 2, scotch tape, 8-1/2 x 8-1/2" paper for each student

BACKGROUND INFORMATION:

The loops cause enough lift to keep the plane in the air.
As it descends, the top part of the loop catches the air and helps the plane stay aloft.

MANAGEMENT:

1. 45-60 minutes

2. Work individually or in pairs.

3. A large open space is required for this activity.

4. Instruct students to launch the planes away from others.

WORD BANK:

lift, thrust, gravity, drag, loop, tube, Venn Diagram, compare, similar, different, flight

Loop Ad-venn-tures

PROCEDURE:

1. Give each pair of students the materials and have them construct the loop and tube planes.

2. Experiment with the two planes. Have students observe the similarities and differences in both flight and design.

3. Working in pairs, students will complete the Venn Diagram and record their observations.

DISCUSSION QUESTIONS:

1. How are the two planes similar? How are they different?

2. How do lift, thrust, drag, and gravity affect these two planes?

3. Have you ever seen an airplane that is similar in design to the loop and tube planes?

EXTENSIONS:

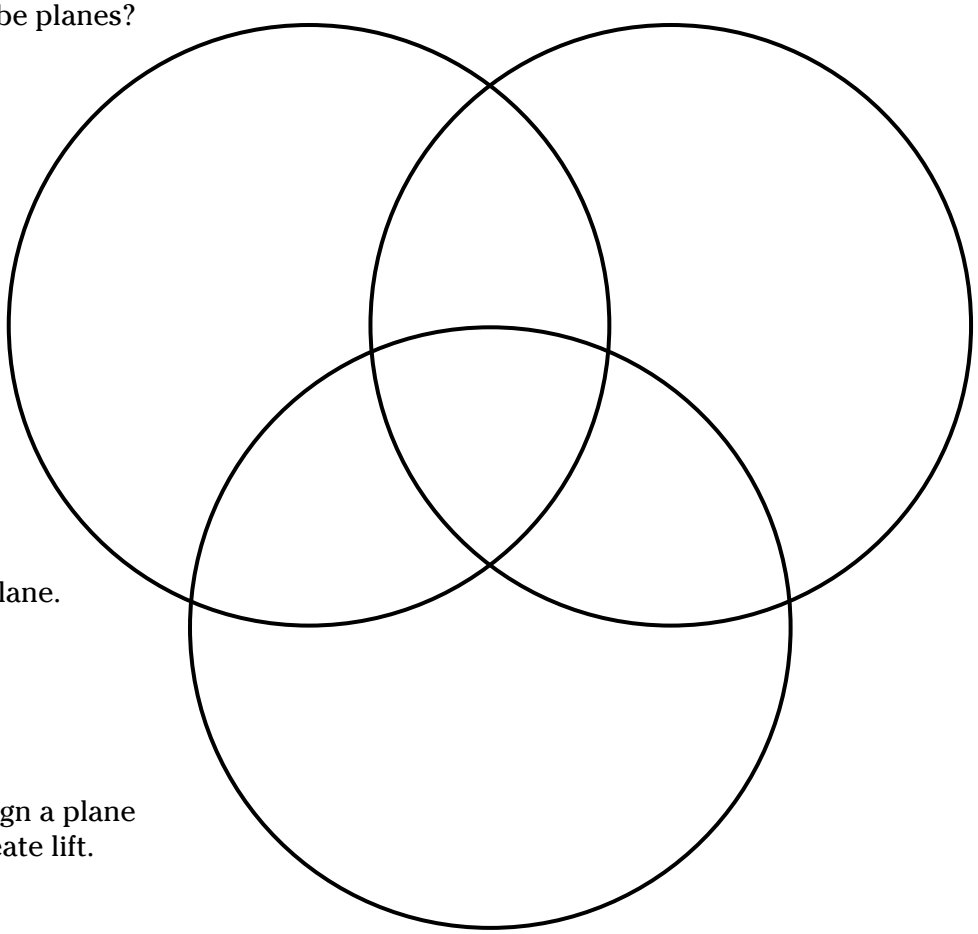
1. Add a third design for an airplane and a third ring to the Venn Diagram to write comparisons.

2. What happens if you use different sized tubes instead of a straw, as the loop plane's fuselage?

3. Use different sized sheets of paper to make the tube plane.

CULMINATING ACTIVITY:

Challenge the students to design a plane that uses multiple loops to create lift.



Loop Ad-venn-tures

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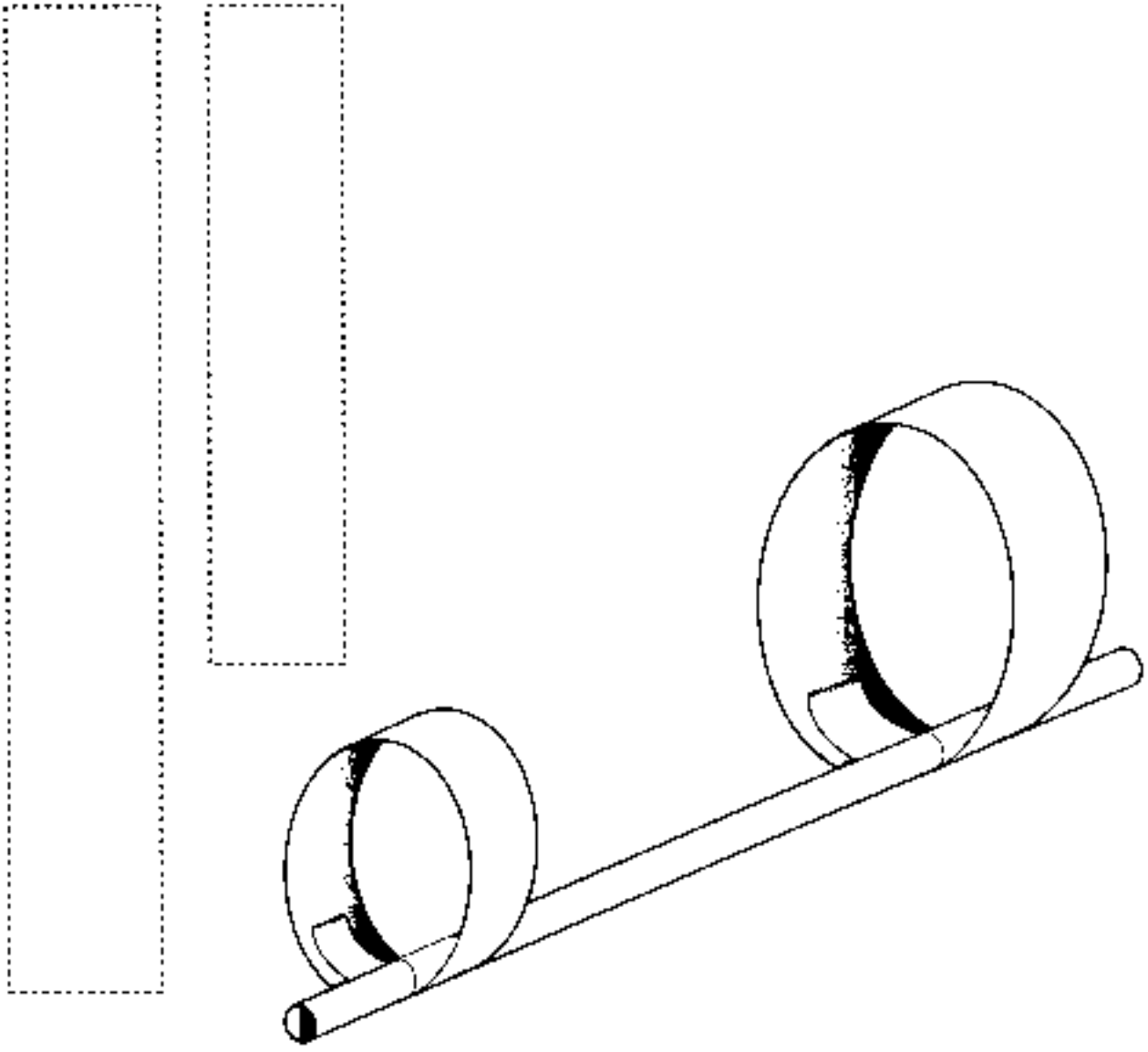
LOOP PLANE

1. Cover both ends of the straw with pieces of tape.

2. Cut out the two loop patterns below.

3. Loops the strips paper and secure with tape.

4. Tape the small loop to one end of the straw and the large loop to the other end.



Loop Ad-venn-tures

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TUBE PLANE

MATERIALS:

8-1/2 x 8-1/2" (square) paper and scotch tape

1. Fold the paper diagonally to find the center point.

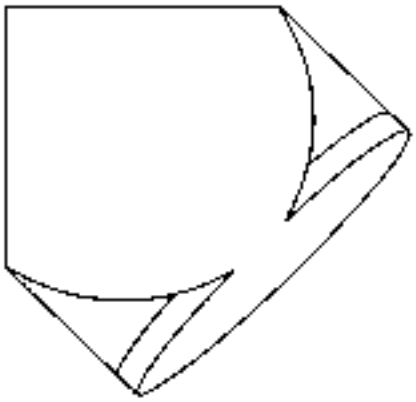
2. Open the paper and fold one corner to the center point.

3. Continue folding to the center (1-centimeter folds).

4. Fold once more past the centerline.

5. With the fold up, run the paper over the edge of the table several times to establish a curve. Then tape the overlapped ends.

6. Pinch at the folded end and gently toss.



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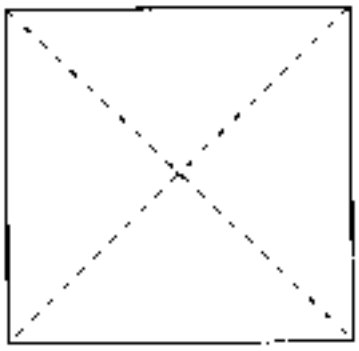

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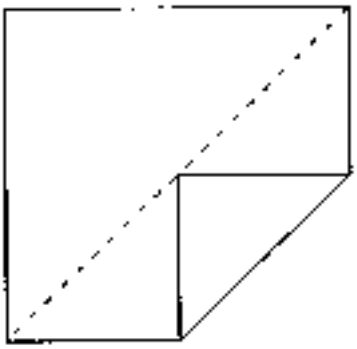

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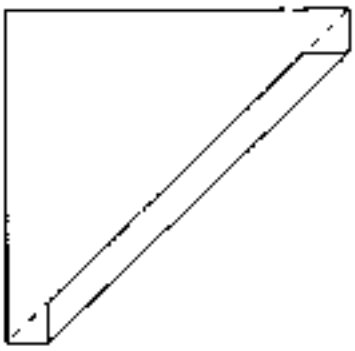

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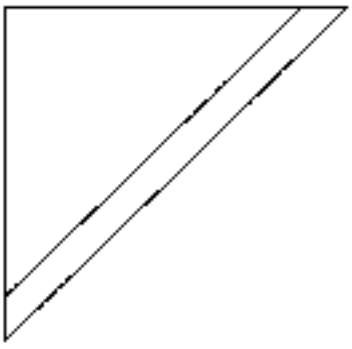

Loop Ad-venn-tures

Pilots: _____