Aerodynamics

Description: Students will explore the differences between a variety of paper airplane models that are provided to the student. Students will examine the differences in construction as well as the differences in launch instructions. Students will decide on a goal (either greatest distance or longest time) and build their own paper airplane from provided instructions to compete towards that goal. While this event can be done in a classroom, a gym or multipurpose room gives participants more room to fly.

Age Group: K-8

Estimated Time: Approximately 15-20 minutes

Recommended Group Size: 2

Key Questions: What are the characteristics of a paper airplane that make it a good design to be flown a great distance? What characteristics of a paper airplane make it stay in the air the longest?

Content Expectations Addressed: Inquiry involves generating questions, conducting investigations, and developing solutions to problems through reasoning and observation.

Inquiry includes an analysis and presentation of findings that lead to future questions, research, and investigations.

Reflecting on knowledge is the application of scientific knowledge to new and different situations. Reflecting on knowledge requires careful analysis of evidence that guides decision-making and the application of science through history and within society.

Earth pulls down on all objects with a force called gravity. With very few exceptions, objects fall to the ground no matter where the object is **on** the Earth.

An object is in motion when its position is changing. The speed of an object is defined by how far it travels divided by the amount of time it took to travel that far.

Motion can be described by a change in position relative to a point of reference. The motion of an object can be described by its speed and the direction it is moving.

Common CORE: Students who read the instructions in order to build their own plane are satisfying the Common Core Technical Reading objective.

Teacher Background:

There are four forces to consider when flying.

1. Thrust – The push forward. On a traditional airplane, the thrust comes from the engines. When flying a paper airplane, the thrust comes from the person launching the plane. Note that once the hand of the person is no longer touching the paper airplane, the thrust force is ZERO. At this point, a paper airplane actually becomes a glider; not a plane.

2. Gravity – The force pulling the plane to the earth. This force acts the same on traditional airplanes as it does on paper airplanes.

3. Drag - Aerodynamics is the term we use for how easily something moves through the air. If it is harder to move through the air, we say that it has a lot of "drag." Drag is a force. In this situation, drag is primarily air resistance. If it is more aerodynamic (or easier to move through the air), then you have minimized the drag.

   An illustration of aerodynamics (drag) is to hold your hand in front of you with your thumb pointing to the ceiling. When you swing your hand back and forth, you can feel the drag force. Now place your thumb/hand parallel to the ground. When you swing it back and forth you will notice it is easier. Your hand is now more aerodynamic and experiences less drag.

4. Lift – This is the force that counteracts gravity. Air above the wing of a plane pushes down. Air below the wing of a plane pushes up. Lift is the comparison of these forces. A plane with a lot of lift has a much greater force up on the wing than down. On an actual airplane, the wings are curved. When the plane begins to move, this curved design allows the air to move faster above the wing, reducing the pressure and the downward force on the wing. This is how an upward lift force is generated; by increasing the speed of the air above the wing compared to the speed of the air below the wing.

Paper airplanes that are designed to fly the greatest distance need to be aerodynamic and "slice" through the air similar to your thumb/hand being parallel to the ground in order to reduce drag. Planes with this design typically need a lot of speed to generate any kind of lift and must therefore be thrown hard. (i.e. Delta, Dart)

Paper airplanes that are designed to fly the longest time typically have a lot of lift and don't require (or do well) with a strong initial thrust (throw). They often fly a long, slow and gentle fight. (i.e. Condor, Raptor, Bulldog)

Materials: Model Planes with ID cards, templates for various airplane designs, scissors, pencils, measuring tape, masking tape, and stopwatch.

Set-Up:

A. Establish a safe place for students to fly planes. For distance flights, you can use masking tape to mark off a starting line on the floor of the gym or multipurpose room and place an "X" on the floor (using masking tape) to use as an optional target.

B. For timed flights, participants may need to stand more towards the middle of the fly area.

C. Near the fly area, place a sample of each paper plane. There is a laminated card to place under each example plane so students see a picture of the plane, the name of the plane, and how the plane should be launched.

D. Have measuring tapes and stopwatches ready.

E. Copies of the instructions to make each plane are included in the kit. You will want to organize the copies so you can find each type of plane quickly.

Procedure:

1. Have students test pre-made paper planes. You will want to point out or help them read launch instructions. While launch instructions are optimal for each design, please allow and encourage students to try different launch styles with each plane.

   As the students experiment with pre-made planes, ask the following questions:

   - What differences do you notice between the designs of the planes?
   - **Which plane do you think stays in the air the longest? Why?**
   - **Which plane do you think will go the farthest? Why?**
   - What plane(s) are you interested in building?

2. Have students construct paper airplanes using their own designs or the ones provided. Have them put their names on the planes for easy identification.
3. As students fly, ask about their plane and why they choose to make that one. If they choose it to fly for a long time, then please use a stopwatch to time it. If they are going for distance, you can have them try to hit a target and/or measure their overall flight distance.

Resources:

Websites

http://www.paperairplanes.co.uk

http://www.funpaperairplanes.com/Plane%20Downloads.html

Books

Kids' Paper Airplane Book. By: Ken Blackburn and Jeff Lammers

Quick and Easy Paper Airplanes That Really Fly. By: Paul Jackson

Aerodynamics

Description: Each team will build a paper airplane to be flown at a distance of at least five meters, landing on a predetermined target. Airplanes must be of a folded aerodynamic design. Crumpled wads of paper do not qualify. Various types of paper and supplies will be available for the students to try out.

Age Group: All

Estimated Time: Approximately 10-15 minutes

Recommended Group Size: 2

Key Questions: What are the characteristics of a paper airplane that is best designed to be flown toward a designated target?

Content Expectations Addressed: Inquiry involves generating questions, conducting investigations, and developing solutions to problems through reasoning and observation.

Inquiry includes an analysis and presentation of findings that lead to future questions, research, and investigations.

Reflecting on knowledge is the application of scientific knowledge to new and different situations. Reflecting on knowledge requires careful analysis of evidence that guides decision-making and the application of science through history and within society.

A position of an object can be described by locating the object relative to other objects or a background. The description of the motion of an object from one observer's view may be different from that reported from a different observer's view.

Earth pulls down on all objects with a force called gravity. With very few exceptions, objects fall to the ground no matter where the object is on the Earth.

An object is in motion when its position is changing. The speed of an object is defined by how far it travels divided by the amount of time it took to travel that far.

Motion can be described by a change in position relative to a point of reference. The motion of an object can be described by its speed and the direction it is moving. The position and speed of an object can be measured and graphed as a function of time.

Teacher Background: For an airplane to fly the forces of lift versus weight and thrust versus drag come into play. As a plane moves forward, the weight or force due to

gravity pulls down on the plane opposing the lift created by air flowing over the wing. Thrust is generated by the propeller and opposes drag caused by air resistance to the airplane. During takeoff, thrust must be greater than drag and lift must be greater than weight so that the airplane can become airborne. In level flight at constant speed, thrust exactly equals drag and lift exactly equals the weight or gravity force. Lift and drag are considered aerodynamic forces because they exist due to the movement of the aircraft through the air. For landings, thrust must be reduced below the level of drag and left below the level of the gravity force or weight.

Science Process Skills: Predicting, experimenting, measuring, and observing.

Materials: Paper, scissors, templates for various airplane designs, metric measuring tape and masking tape.

Procedure: Have students construct simple paper airplanes using their own designs or the ones provided. Have them put their names on the planes for easy identification. Use masking tape to mark off a starting line on the floor of the gym or multipurpose room. Have the students line up behind the masking tape. On a signal, the first student steps up, aims at the finish line, and throws his/her plane. The distance the plane flies is measured in meters and announced. Some directions for making paper airplanes are included.

The best way to fly this plane is to hold it at about 1/4 of its length from the nose tip and throw it overhand quite gently.

Resources:

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http://www.funpaperairplanes.com/Plane%20Downloads.html

Books

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Discovering STEM Program

Aerodynamics

Description: Students will explore the differences between a variety of paper airplane models that are provided to the student. Students will examine the differences in construction as well as the differences in launch instructions. Students will decide on a goal (either greatest distance or longest time) and build their own paper airplane from provided instructions to compete towards that goal. While this event can be done in a classroom, a gym or multipurpose room gives participants more room to fly.

Age Group: K-8

Estimated Time: Approximately 15-20 minutes

Recommended Group Size: 2

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   An illustration of aerodynamics (drag) is to hold your hand in front of you with your thumb pointing to the ceiling. When you swing your hand back and forth, you can feel the drag force. Now place your thumb/hand parallel to the ground. When you swing it back and forth you will notice it is easier. Your hand is now more aerodynamic and experiences less drag.

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Quick and Easy Paper Airplanes That Really Fly. By: Paul Jackson

Elementary Grade Level Expectations Met By Aerodynamics

Science Process

Kindergarten

Inquiry Process

S.IP.00.12: Generate questions based upon observations.
S.IP.00.13: Plan and conduct simple investigations.
S.IP.00.15: Make accurate measurements with appropriate (non-standard) units for the measurement tool.

Inquiry Analysis and Communication

S.IA.00.13: Communicate and present findings of observations.
S.IA.00.14: Develop strategies for information gathering.

Reflection and Social Implications

S.RS.00.11: Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.

First Grade

Inquiry Process

S.IP.01.12: Generate questions based upon observations.
S.IP.01.13: Plan and conduct simple investigations.
S.IP.01.15: Make accurate measurements with appropriate (non-standard) units for the measurement tool.

Inquiry Analysis and Communication

S.IA.01.13: Communicate and present findings of observations.
S.IA.01.14: Develop strategies for information gathering.

Reflection and Social Implications

S.RS.01.11: Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
S.RS.01.12: Recognize that science investigations are done more than one time.

Second Grade

Inquiry Process

S.IP.02.12: Generate questions based upon observations.
S.IP.02.13: Plan and conduct simple investigations.
S.IP.02.15: Make accurate measurements with appropriate units for the measurement tool.

Inquiry Analysis and Communication

S.IA.02.13: Communicate and present findings of observations.
S.IA.02.14: Develop strategies for information gathering and problem solving.

Reflection and Social Implications

S.RS.02.11: Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
S.RS.02.13: Recognize that when a science investigation is done the way it was done before, similar results are expected.

Elementary Grade Level Expectations Met By Aerodynamics

Third Grade

Inquiry Process

S.IP.03.12: Generate questions based upon observations.
S.IP.03.13: Plan and conduct simple and fair investigations.
S.IP.03.15: Make accurate measurements with appropriate units for the measurement tool.

Inquiry Analysis and Communication

S.IA.03.13: Communicate and present findings of observations and investigations.
S.IA.03.15: Compare and contrast sets of data from multiple trials of a science investigation to explain reasons for differences.

Reflection and Social Implications

S.RS.03.11: Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
S.RS.03.14: Use data/samples as evidence to separate fact from opinion.

Fourth Grade

Inquiry Process

S.IP.04.12: Generate questions based upon observations.
S.IP.04.13: Plan and conduct simple and fair investigations.
S.IP.04.15: Make accurate measurements with appropriate units for the measurement tool.

Inquiry Analysis and Communication

S.IA.04.13: Communicate and present findings of observations and investigations.
S.IA.04.15: Compare and contrast sets of data from multiple trials of a science investigation to explain reasons for differences.

Reflection and Social Implications

S.RS.04.11: Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
S.RS.04.14: Use data/samples as evidence to separate fact from opinion.
S.RS.04.15: Use evidence when communicating scientific ideas.

Fifth Grade

Inquiry Process

S.IP.05.11: Generate questions based upon observations, investigations, and research.
S.IP.05.12: Design and conduct scientific investigations.
S.IP.05.14: Use metric measurement devices in an investigation.

Inquiry Analysis and Communication

S.IA.05.12: Evaluate data, claims, and personal knowledge through collaborative science discourse.
S.IA.05.14: Draw conclusions from sets of data from multiple trials of a scientific investigation.

Reflection and Social Implications

S.RS.05.11: Evaluate the strengths and weaknesses of claims, arguments, and data.
S.RS.05.15: Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.

Elementary Grade Level Expectations Met By Aerodynamics

Physical Science

Lower Elementary

Force and Motion

P.FM.00.11: Compare the position of an object in relation to other objects around it.
P.FM.00.21: Observe how objects fall towards the Earth.
P.FM.00.34: Observe how shape, size, and weight of an object can affect motion.

Upper Elementary

Force and Motion

P.FM.03.22: Identify the force that pulls objects towards the Earth.
P.FM.03.42: Identify changes in motion.
P.FM.05.41: Explain the motion of an object relative to its point of reference.
P.FM.05.42: Describe the motion of an object in terms of distance, time and direction, as the object moves, and in relationship to other objects.

Elementary Grade Level Expectations Met By Aerodynamics

Science Process

Kindergarten

Inquiry Process

S.IP.00.12: Generate questions based upon observations.
S.IP.00.13: Plan and conduct simple investigations.
S.IP.00.15: Make accurate measurements with appropriate (non-standard) units for the measurement tool.

Inquiry Analysis and Communication

S.IA.00.13: Communicate and present findings of observations.
S.IA.00.14: Develop strategies for information gathering.

Reflection and Social Implications

S.RS.00.11: Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.

First Grade

Inquiry Process

S.IP.01.12: Generate questions based upon observations.
S.IP.01.13: Plan and conduct simple investigations.
S.IP.01.15: Make accurate measurements with appropriate (non-standard) units for the measurement tool.

Inquiry Analysis and Communication

S.IA.01.13: Communicate and present findings of observations.
S.IA.01.14: Develop strategies for information gathering.

Reflection and Social Implications

S.RS.01.11: Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
S.RS.01.12: Recognize that science investigations are done more than one time.

Second Grade

Inquiry Process

S.IP.02.12: Generate questions based upon observations.
S.IP.02.13: Plan and conduct simple investigations.
S.IP.02.15: Make accurate measurements with appropriate units for the measurement tool.

Inquiry Analysis and Communication

S.IA.02.13: Communicate and present findings of observations.
S.IA.02.14: Develop strategies for information gathering and problem solving.

Reflection and Social Implications

S.RS.02.11: Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
S.RS.02.13: Recognize that when a science investigation is done the way it was done before, similar results are expected.

Elementary Grade Level Expectations Met By Aerodynamics

Third Grade

Inquiry Process

S.IP.03.12: Generate questions based upon observations.
S.IP.03.13: Plan and conduct simple and fair investigations.
S.IP.03.15: Make accurate measurements with appropriate units for the measurement tool.

Inquiry Analysis and Communication

S.IA.03.13: Communicate and present findings of observations and investigations.
S.IA.03.15: Compare and contrast sets of data from multiple trials of a science investigation to explain reasons for differences.

Reflection and Social Implications

S.RS.03.11: Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
S.RS.03.14: Use data/samples as evidence to separate fact from opinion.

Fourth Grade

Inquiry Process

S.IP.04.12: Generate questions based upon observations.
S.IP.04.13: Plan and conduct simple and fair investigations.
S.IP.04.15: Make accurate measurements with appropriate units for the measurement tool.

Inquiry Analysis and Communication

S.IA.04.13: Communicate and present findings of observations and investigations.
S.IA.04.15: Compare and contrast sets of data from multiple trials of a science investigation to explain reasons for differences.

Reflection and Social Implications

S.RS.04.11: Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
S.RS.04.14: Use data/samples as evidence to separate fact from opinion.
S.RS.04.15: Use evidence when communicating scientific ideas.

Fifth Grade

Inquiry Process

S.IP.05.11: Generate questions based upon observations, investigations, and research.
S.IP.05.12: Design and conduct scientific investigations.
S.IP.05.14: Use metric measurement devices in an investigation.

Inquiry Analysis and Communication

S.IA.05.12: Evaluate data, claims, and personal knowledge through collaborative science discourse.
S.IA.05.14: Draw conclusions from sets of data from multiple trials of a scientific investigation.

Reflection and Social Implications

S.RS.05.11: Evaluate the strengths and weaknesses of claims, arguments, and data.
S.RS.05.15: Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.

Elementary Grade Level Expectations Met By Aerodynamics

Physical Science

Lower Elementary

Force and Motion

P.FM.00.11: Compare the position of an object in relation to other objects around it.
P.FM.00.21: Observe how objects fall towards the Earth.
P.FM.00.34: Observe how shape, size, and weight of an object can affect motion.

Upper Elementary

Force and Motion

P.FM.03.22: Identify the force that pulls objects towards the Earth.
P.FM.03.42: Identify changes in motion.
P.FM.05.41: Explain the motion of an object relative to its point of reference.
P.FM.05.42: Describe the motion of an object in terms of distance, time and direction, as the object moves, and in relationship to other objects.

Middle School Grade Level Expectations Met By Aerodynamics

Science Process

Sixth Grade

Inquiry Process

S.IP.06.11: Generate questions based upon observations, investigations, and research.
S.IP.06.12: Design and conduct scientific investigations.
S.IP.06.14: Use metric measurement devices in an investigation.

Inquiry Analysis and Communication

S.IA.06.12: Evaluate data, claims, and personal knowledge through collaborative science discourse.
S.IA.06.14: Draw conclusions from sets of data from multiple trials of a scientific investigation.

Reflection and Social Implications

S.RS.06.11: Evaluate the strengths and weaknesses of claims, arguments, and data.
S.RS.06.14: Evaluate scientific explanations based on current evidence and scientific principles.
S.RS.06.15: Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.

Seventh Grade

Inquiry Process

S.IP.07.11: Generate questions based upon observations, investigations, and research.
S.IP.07.12: Design and conduct scientific investigations.
S.IP.07.14: Use metric measurement devices in an investigation.

Inquiry Analysis and Communication

S.IA.07.12: Evaluate data, claims, and personal knowledge through collaborative science discourse.
S.IA.07.14: Draw conclusions from sets of data from multiple trials of a scientific investigation.

Reflection and Social Implications

S.RS.07.11: Evaluate the strengths and weaknesses of claims, arguments, and data.
S.RS.07.13: Identify the need for evidence in making scientific decisions.
S.RS.07.15: Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.

Middle School Grade Level Expectations Met By Aerodynamics

Science Process

Sixth Grade

Inquiry Process

S.IP.06.11: Generate questions based upon observations, investigations, and research.
S.IP.06.12: Design and conduct scientific investigations.
S.IP.06.14: Use metric measurement devices in an investigation.

Inquiry Analysis and Communication

S.IA.06.12: Evaluate data, claims, and personal knowledge through collaborative science discourse.
S.IA.06.14: Draw conclusions from sets of data from multiple trials of a scientific investigation.

Reflection and Social Implications

S.RS.06.11: Evaluate the strengths and weaknesses of claims, arguments, and data.
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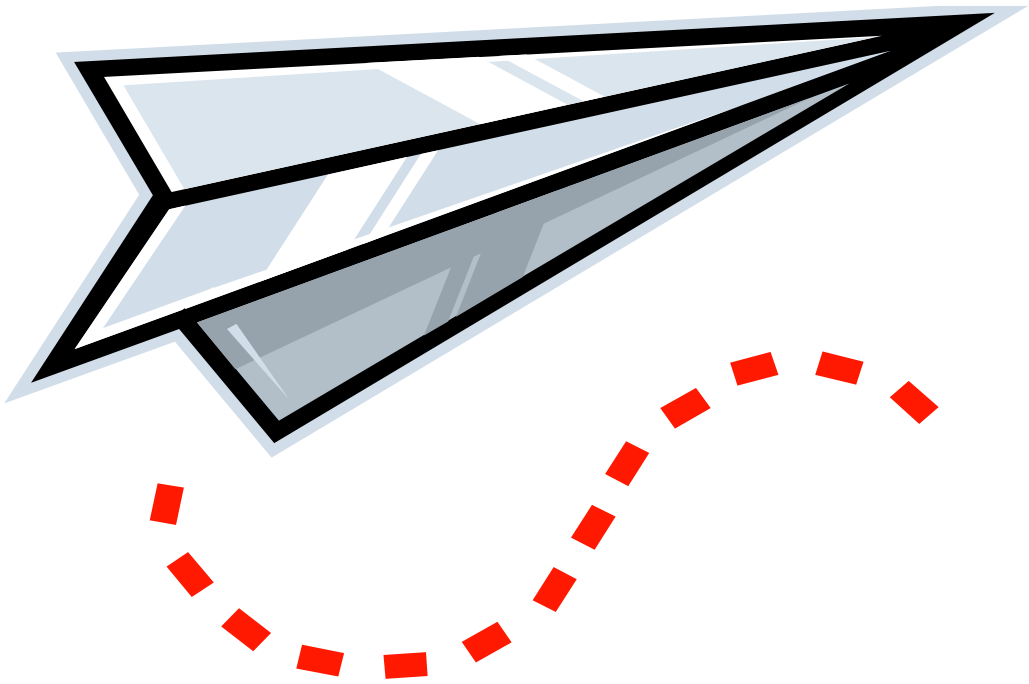
Aerodynamics Materials & Consumables list

*__Indicates a consumable item, please replace*__

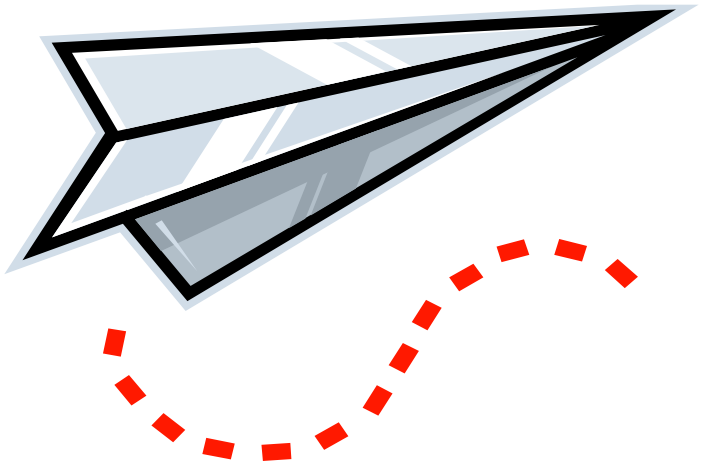
Quantity	Material Description
1	Direction Binder
6	***Pre-Made Planes***
6	Laminated Launch Instructions
6 x 2	Laminated Build Instructions
6 x 40	***Plane templates***
22	Assorted Scissors
2	Measuring Tapes
2 rolls	***Masking Tape***
2 x 100	***Paper Clips***
30	Pencils **(*Sharp*)**
2	Stopwatches

Discovering STEM
Program



Aerodynamics

Discovering STEM Program



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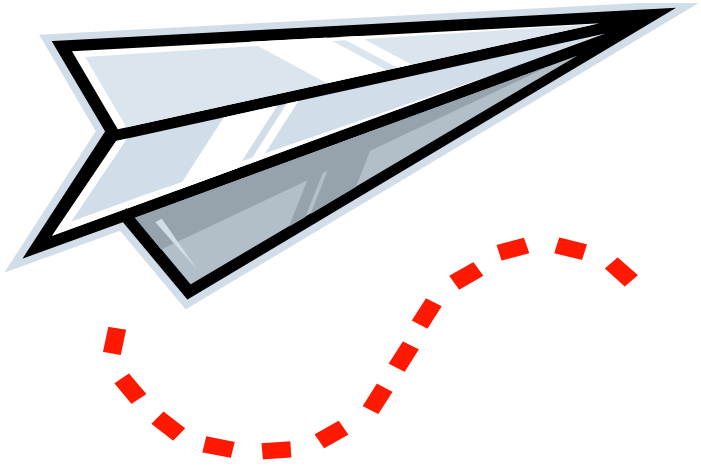

Aerodynamics

Discovering STEM Program

Aerodynamics

Materials & Consumables Inventory List

Teachers:

Please check the inventory list when you receive the kit and recheck it after use. **Report any missing or damaged items to RMSC.**

Thank you!

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2 rolls	***Masking Tape***			
2 x 100	***Paper Clips***			
30	Pencils **(*Sharp*)**			
2	Stopwatches			

* **Indicates consumable item.**

Plane	Color
Delta	Blue
Dart	Grey
Condor	Green
Raptor	Yellow

Regional Math and Science Center

Grand Valley State University

Dragonfly	Purple
Bulldog	Orange

Discovering STEM Program

Aerodynamics

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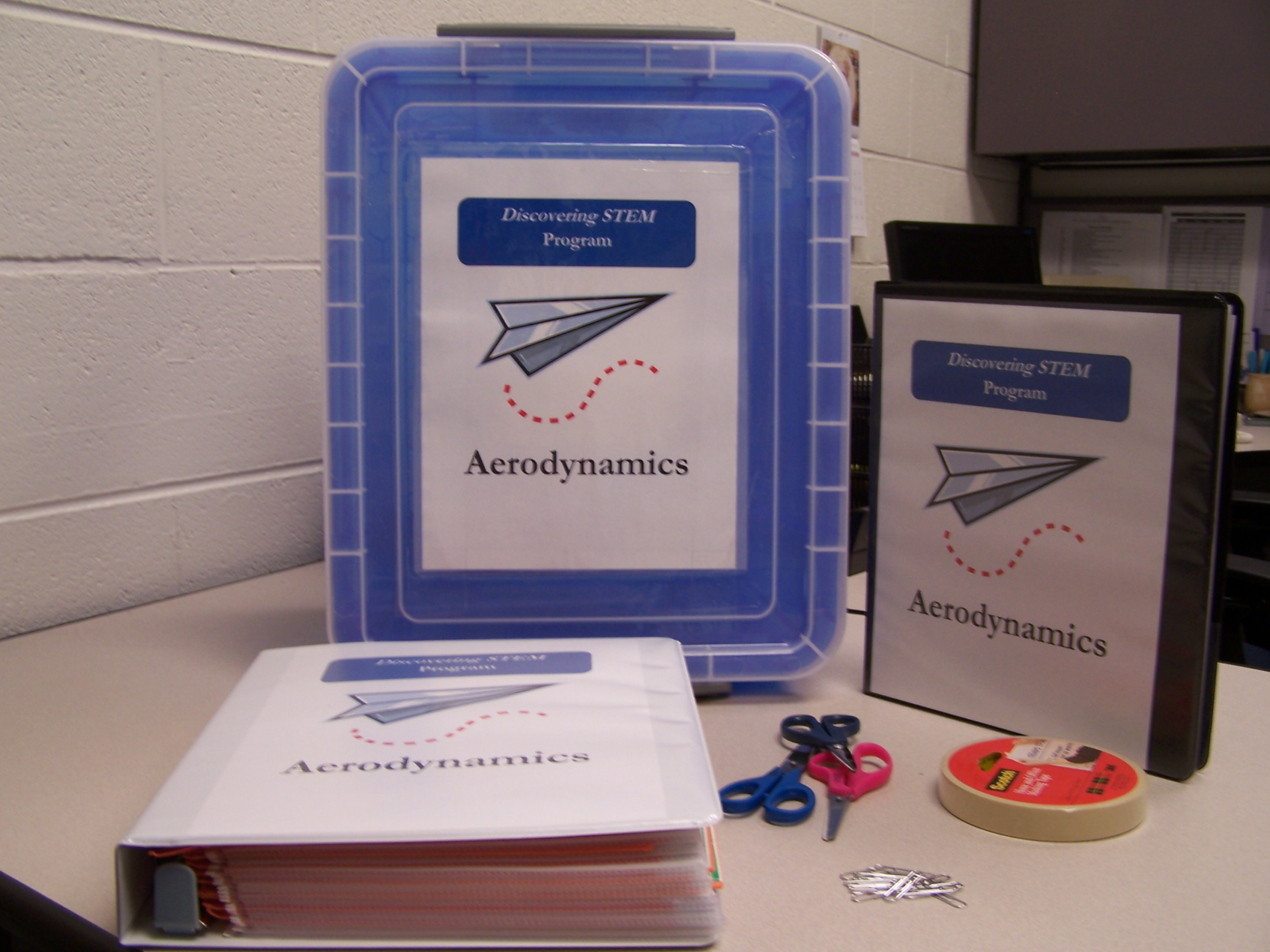
6 x 20	***Plane templates*** Can print more if needed.			
22	Assorted Scissors			
2	Measuring Tapes			
2 rolls	***Masking Tape***			
2 x 100	***Paper Clips***			
30	Pencils **(*Sharp*)**			
2	Stopwatches			

* **Indicates consumable item.**

Plane	Color
Delta	Blue
Dart	Grey
Condor	Green
Raptor	Yellow
Dragonfly	Purple
Bulldog	Orange

Regional Math and Science Center

Grand Valley State University


Discovering STEM
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Discovering STEM
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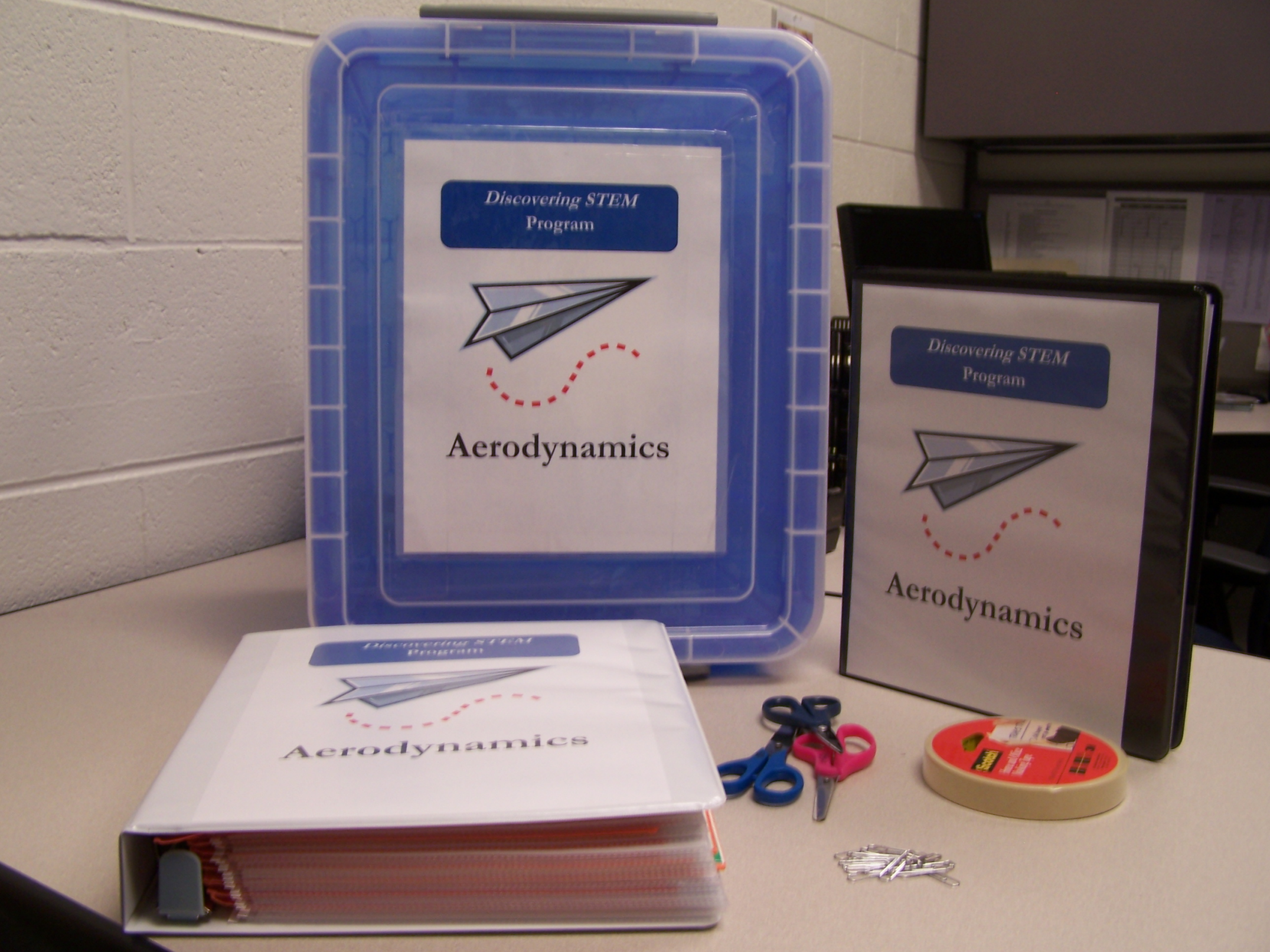
Aerodynamics


Discovering STEM
Program
Aerodynamics
Discovering STEM
Program
Aerodynamics
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Program
Aerodynamics

BULLDOG

Launch Instructions:

The best way to fly this plane is to hold it at about ¼ of its length from the nose tip and throw at a slight angle up with a moderate to small force.

Due to the weight distribution of the plane and wing style, the plane is a very stable glider that flies straight.
Please note that it is also the most challenging to build (but worth it!).

BULLDOG

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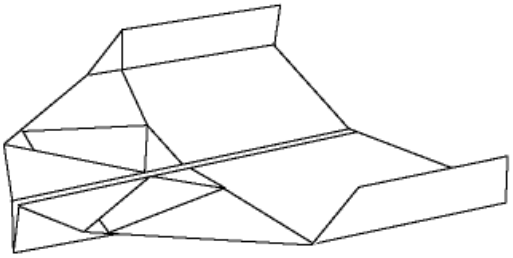
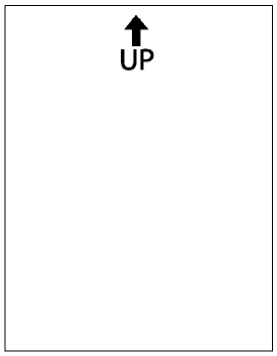
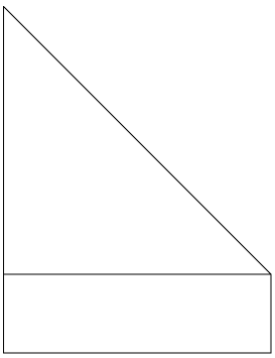
Bulldog



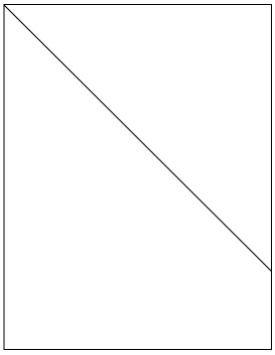
The Bulldog has a compact nose section that makes it very stable by keeping the center of gravity forward. It flies well indoors or in very light breezes outdoors.



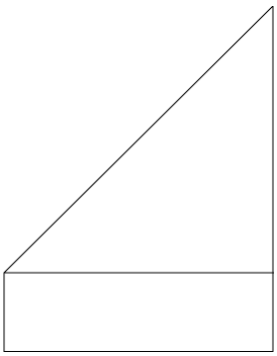
Orient the template with the "UP" arrow at the top of the page. Then, flip the paper over onto its backside, so that you cannot see any of the fold lines.



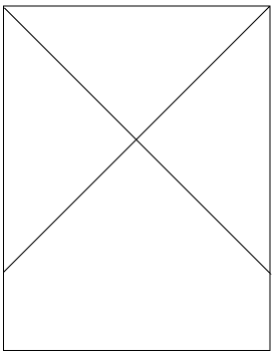
Fold the top right corner down and to the left until fold line 1 appears and crease along the dotted line.



Unfold the fold you just created.



Repeat the procedure above by folding the top left corner down and to the right. Make a crease along fold line 2.



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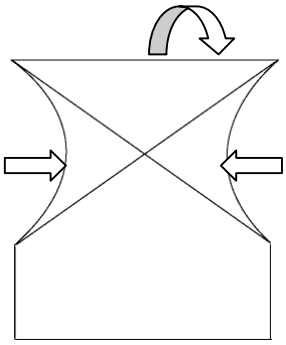
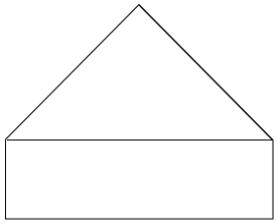
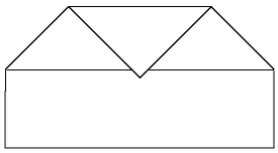


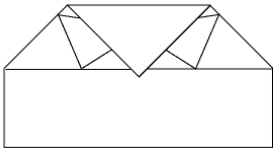
This step is a bit tricky. Lift the left and right edges of the paper and push them toward each other while folding the top triangle onto the bottom one. Make a crease along fold lines 3 so that you end up with the shape below.



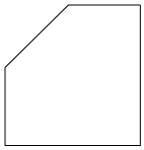
This is the shape you should have after completing the step above.



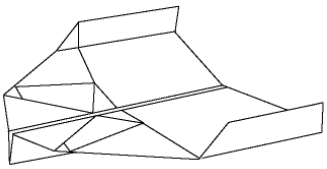
Fold the nose down until fold line 4 appears and make a crease along the dotted line.



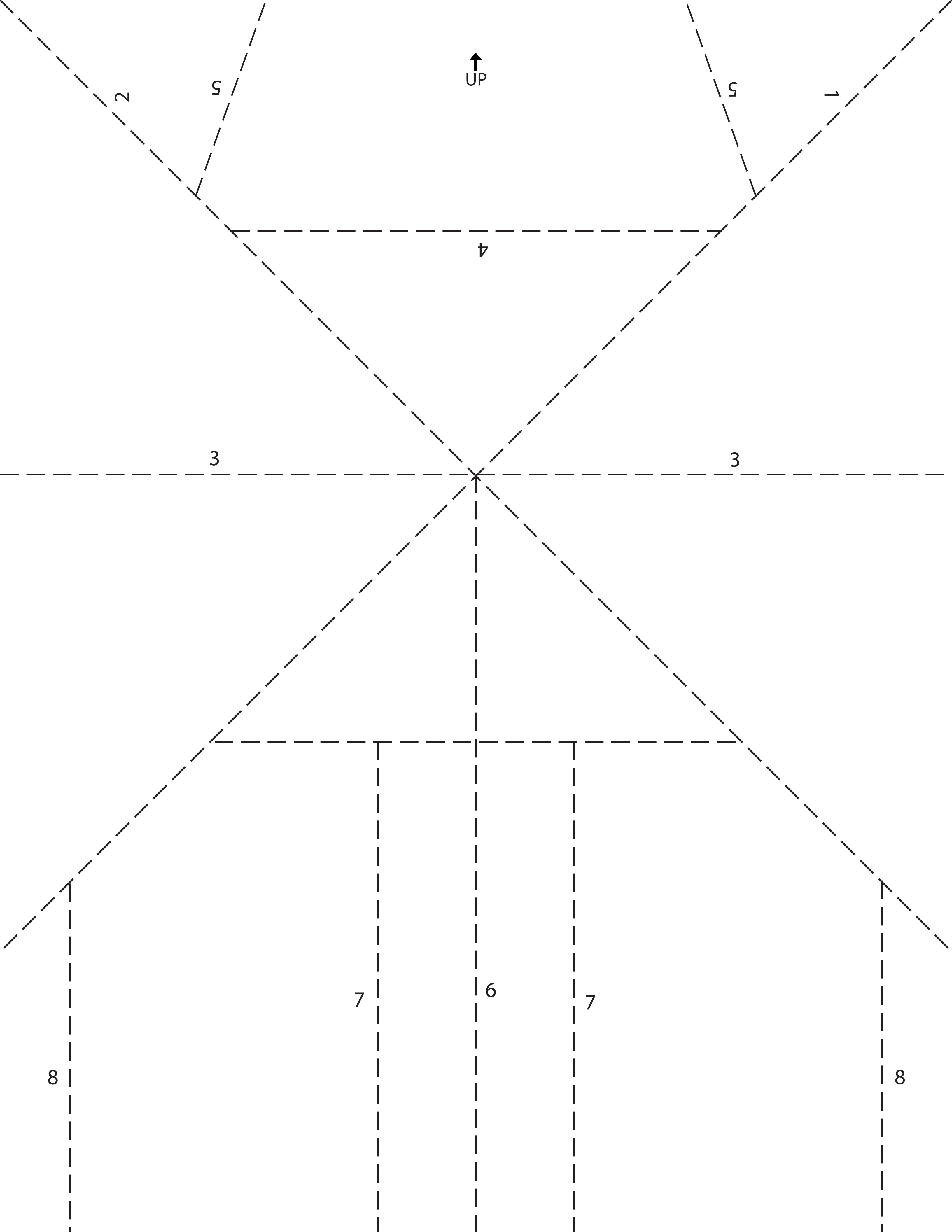
Fold the left and right flaps in and crease along fold lines 5. Tuck these flaps into the pockets in the nose.



Fold the right half of the plane over onto the left half and crease along fold line 6 so that the outside edges of the wings line up.



Fold the wings down along fold lines 7 and the winglets up along fold lines 8. Add wing dihedral by tilting the wings up slightly away from the fuselage. The wings will have a slight "V" shape when viewed from the front. You are ready to fly!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CONDOR

Launch Instructions:

The best way to fly this plane is to hold it at about ¼ of its length from the nose tip and throw at a slight angle up with a STRAIGHT up with a small force.

Due to the wing design and weight distribution of the plane, the plane produces a tremendous lift at low speeds.

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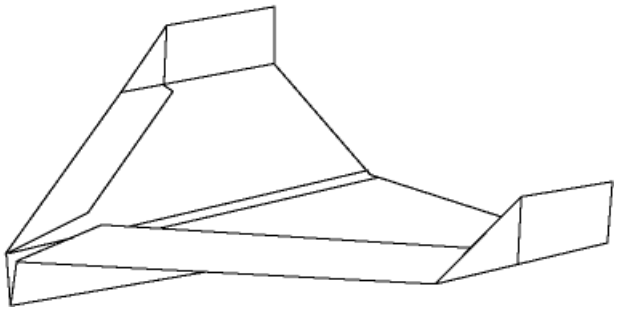
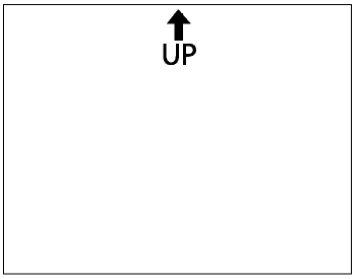
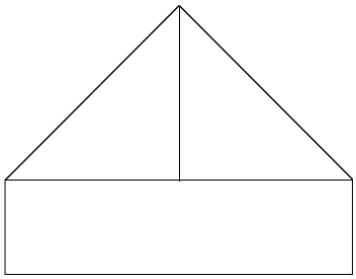
Condor



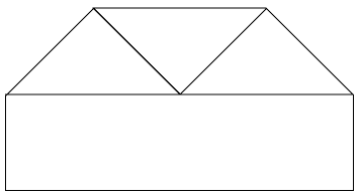
This plane produces tremendous lift at low speed, giving it a very low glide slope. It is an excellent indoor flier and will coast across the room on slow, smooth glides.



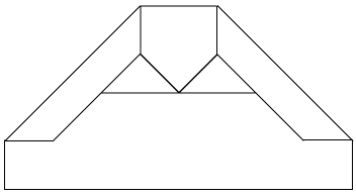
Orient the template so that the "UP" arrow is at the top of the page. Then flip the paper over so that none of the fold lines are showing.



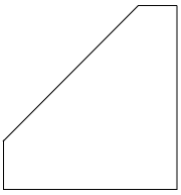
Fold the top left corner down toward you until fold line 1 becomes visible. Crease along the dotted line and repeat with the top right corner.



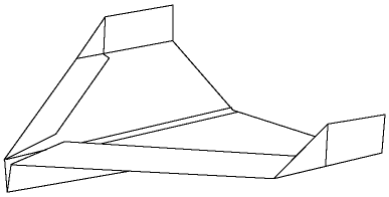
Fold the nose down until fold line 2 becomes visible and crease along the dotted line.



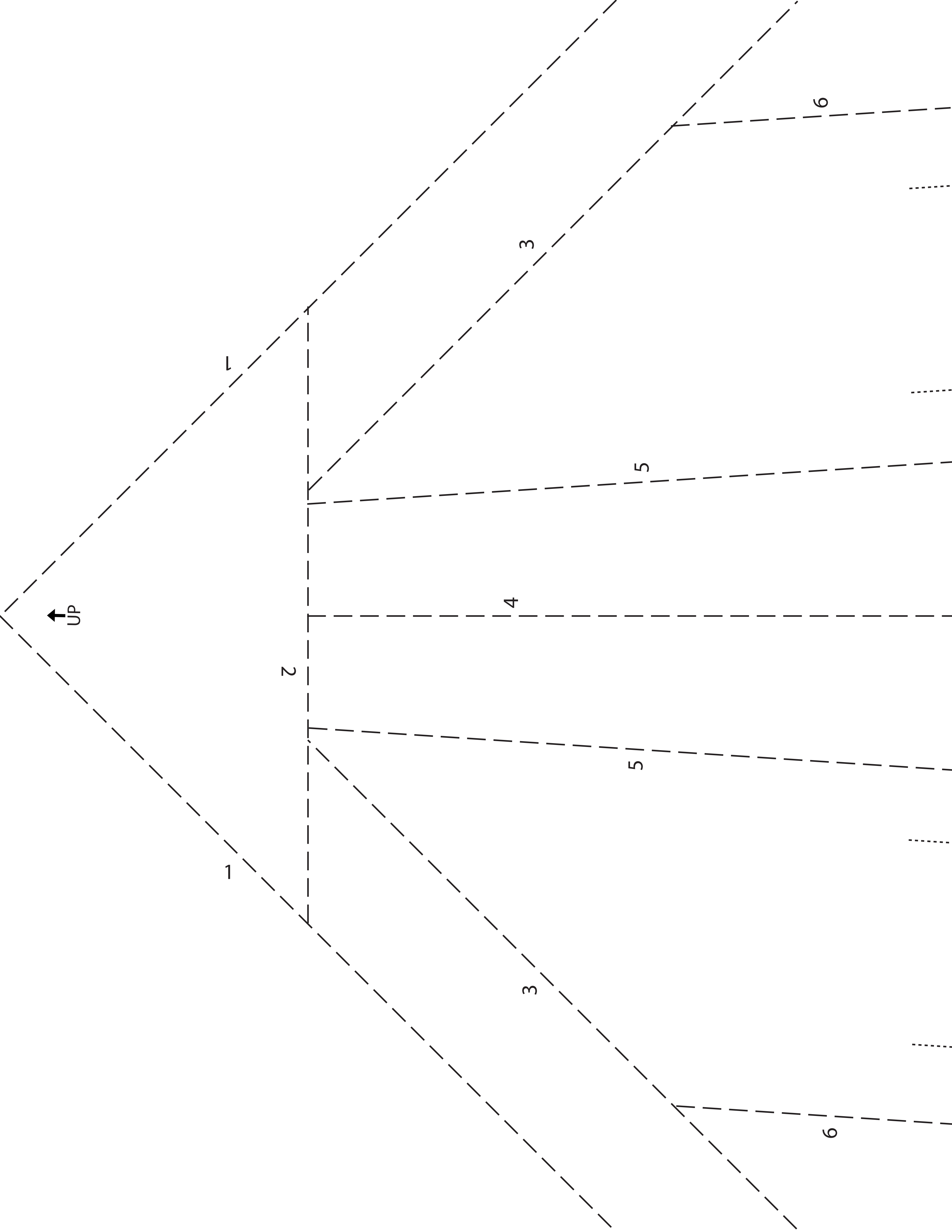
Fold the outside wing edges in and crease along fold lines 3.



Fold the right half of the plane over the left half and crease along fold line 4 so that the outside edges of the wings line up.



Fold the wings down along fold lines 5 and the winglets up along fold lines 6. Add wing dihedral by tilting the wings up slightly away from the fuselage. The wings will have a slight "V" shape when viewed from the front. Add elevator slits along the back edge of the wings to adjust the flight if necessary. You are ready to fly!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DART

Launch Instructions:

The best way to fly this plane is to hold it at about ¼ of its length from the nose tip and throw the plane With moderate force.

The design of the Dart is relatively aerodynamic. The shape reduces drag and provides better weight distribution.
The wing design assists in gliding.

DART

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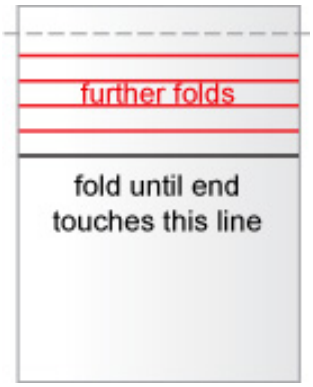
DART

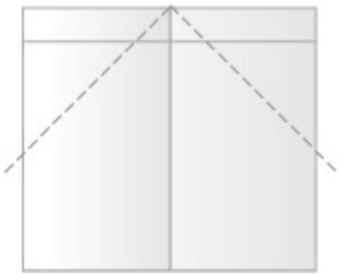
DART

DART

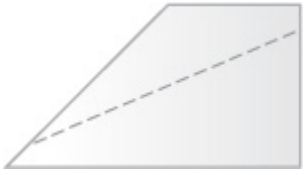
Step 1: First take a rectangular (8 1/2" by 11") sheet of paper and fold down the center; opening it out again afterwards as shown to the left.



Step 2: Take the first 1cm (1/2") of the rectangular sheet and fold it up along the dotted line as shown to the left. Fold the flap over and over until about 3/8 of the length of the sheet is folded in this concertina fashion. This should give a heavy and thick front lip. (Leave folded.)



Step 3: Now fold along the two dotted lines shown to the left by bringing the top edges into the center line (Leave them folded in). Fold along the center line so that from the side, it looks like the picture for Step 4.



Step 4: This should be the side view of your plane. Now fold along the two dotted lines to bring down the wings. Your plane should look like the diagram at the top of the page.

http://www.paperairplanes.co.uk/rapier.php#instructions

DART

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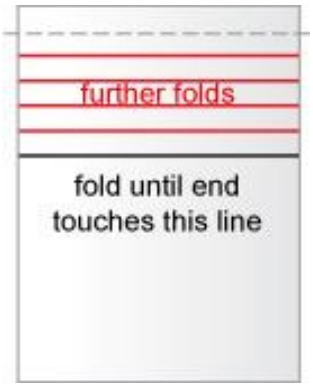

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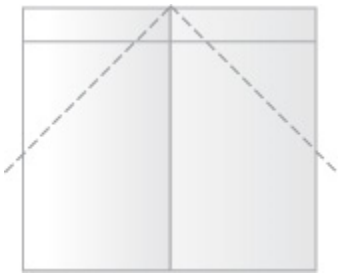

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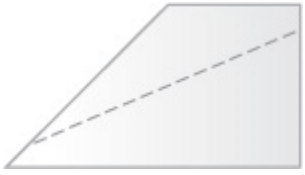

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DELTA

Launch Instructions:

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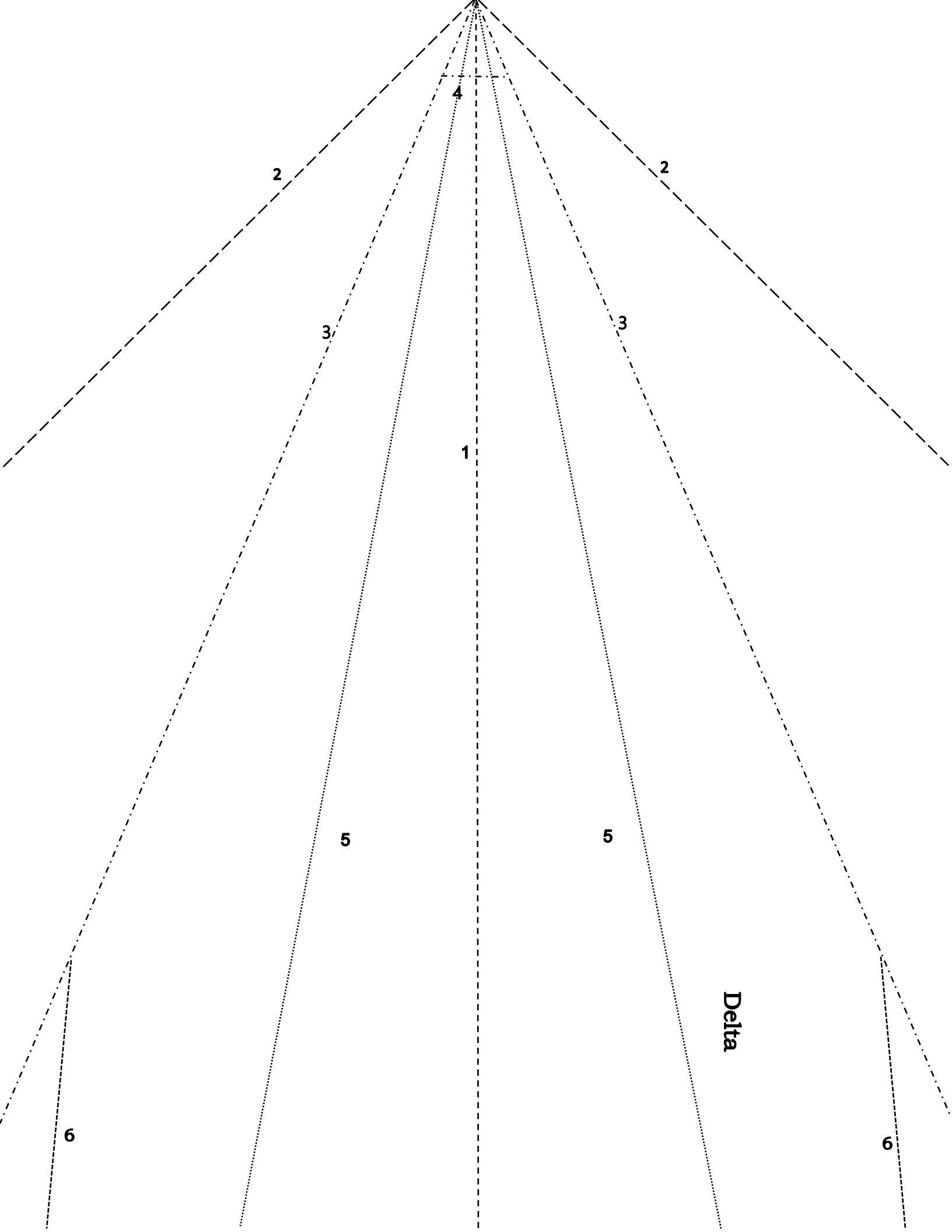
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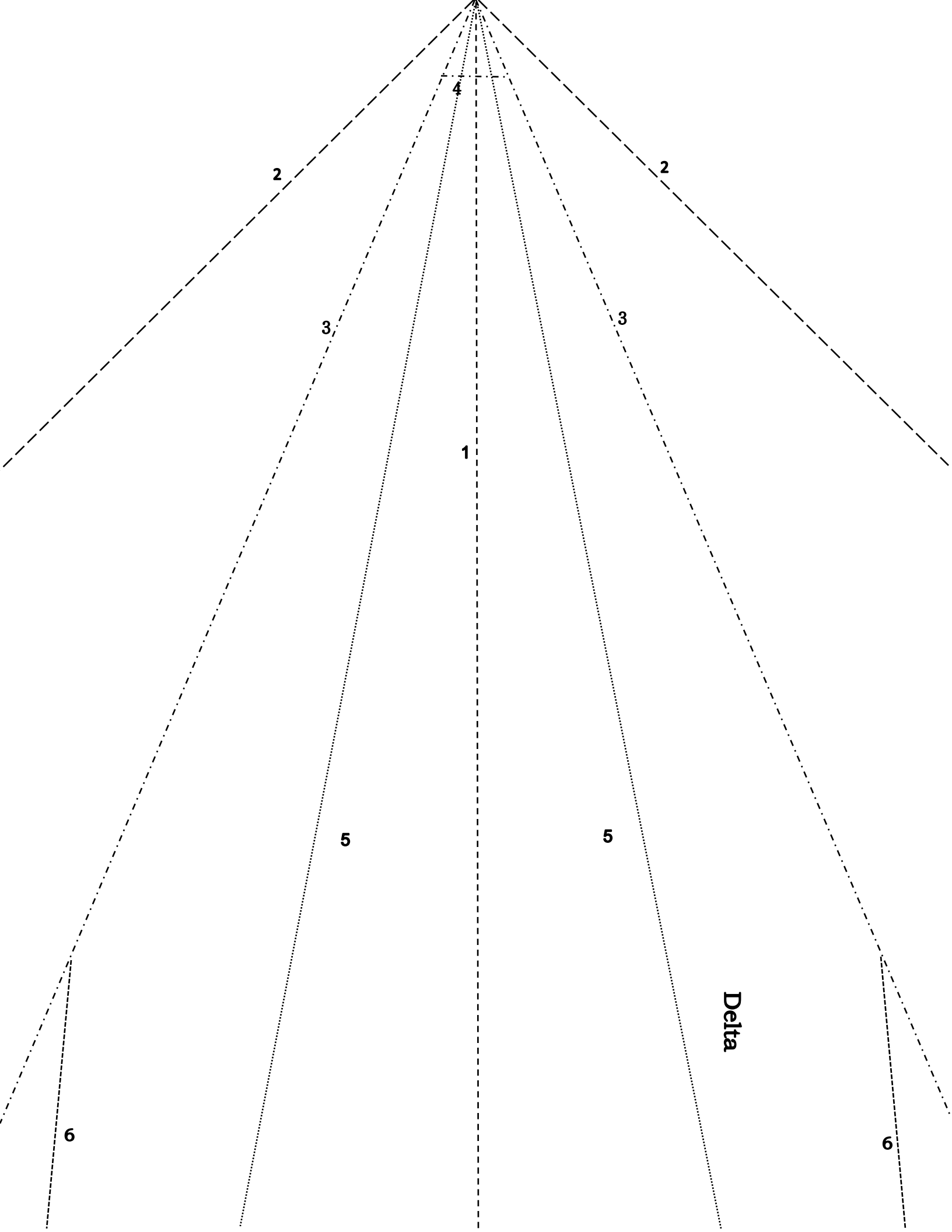
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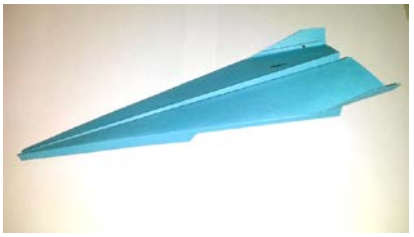
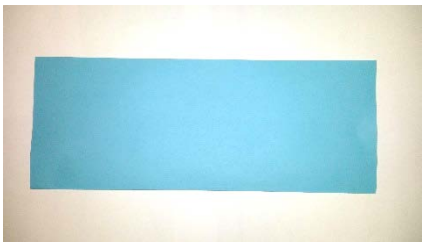
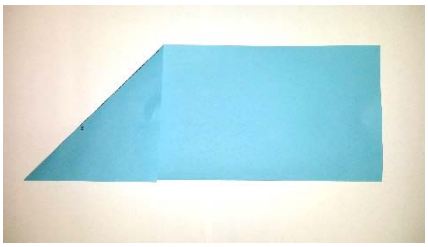
DELTA

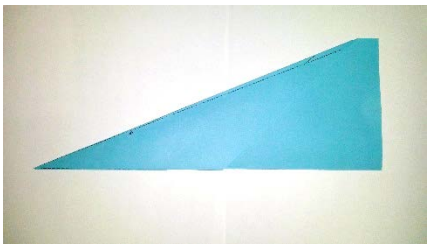




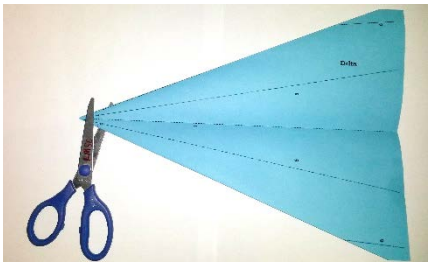
1. Fold the paper along line 1 so that when it is folded, none of the lines are visible.



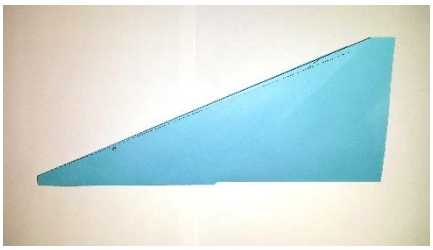
2. Fold down the top edge until you can see line 2. Repeat this for both sides.



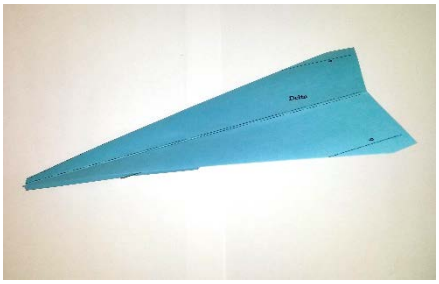
3. Fold down the top edge again until you can see line 3. Repeat this for both sides.



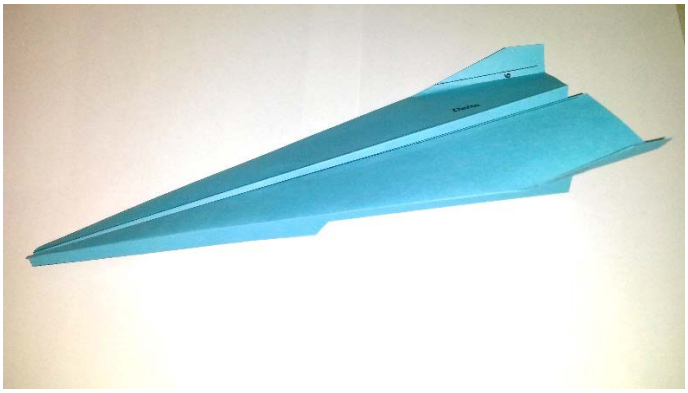
4. Open the plane and CUT along line 4. (This removes the sharp point of the plane).



5. Close plane.

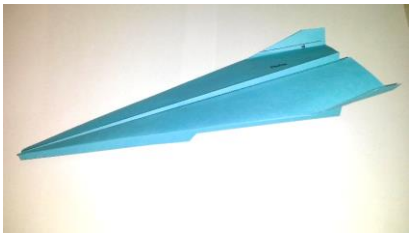


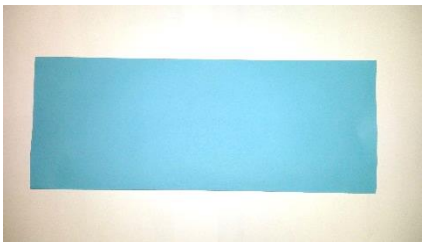
6. To form the wings, fold down the top edges again until you can see line 5. Repeat this for both sides.



7. Fold up along line 6 to finish the Delta.

DELTA





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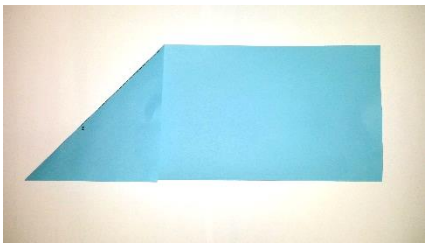
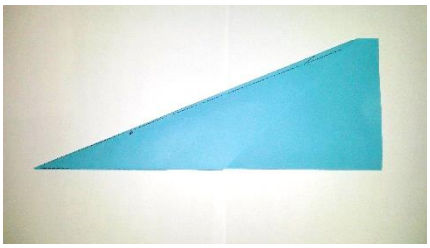


2. Fold down the top edge until you can see line 2. Repeat this for both sides.



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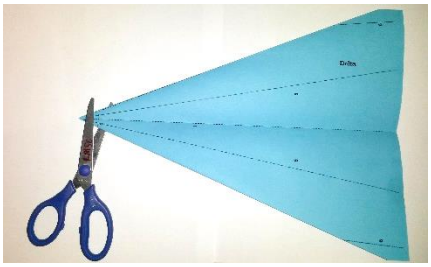
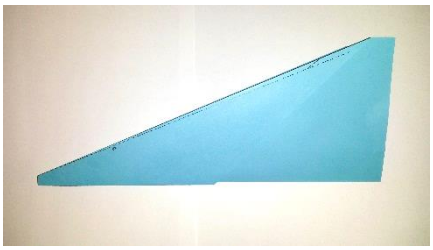
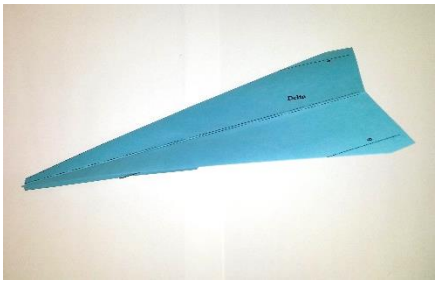


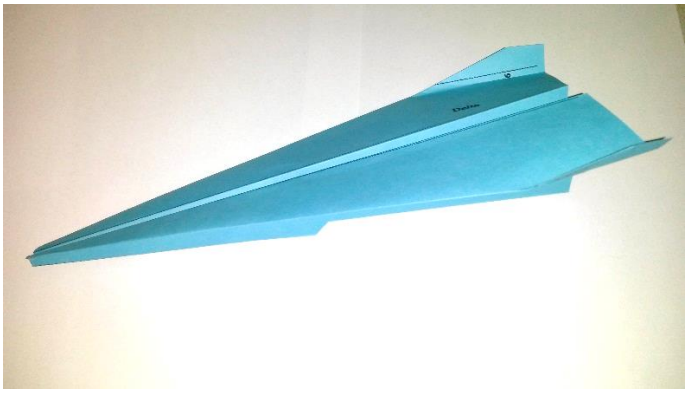
4. Open the plane and CUT along line 4. (This removes the sharp point of the plane).



5. Close plane.



6. To form the wings, fold down the top edges again until you can see line 5. Repeat this for both sides.



7. Fold up along line 6 to finish the Delta.

DRAGONFLY

Launch Instructions:

The best way to fly this plane is to hold it at about ¼ of its length from the nose tip and throw at a slight angle up with a STRAIGHT up with a moderate force.

Due to the wing design and weight distribution of the plane, when thrown hard, it will fly in large vertical loops.

DRAGONFLY

Launch Instructions:

The best way to fly this plane is to hold it at about ¼ of its length from the nose tip and throw at a slight angle up with a STRAIGHT up with a moderate force.

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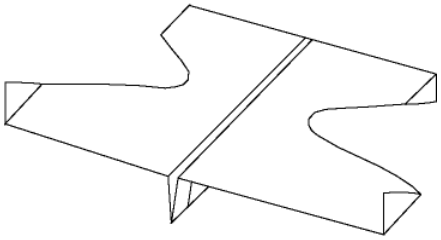
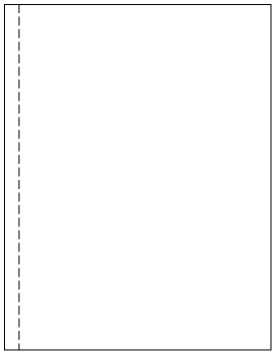
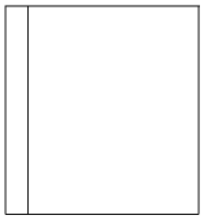
Dragonfly



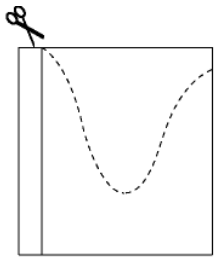
This unusual plane gets its name from its two sets of nearly symmetrical wings that resemble a dragonfly when viewed from the top. This plane is very aerobatic, and will tend to loop if thrown hard outdoors.



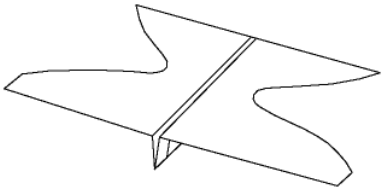
Begin by folding toward you along the first fold line. Continue folding this strip over itself until you reach the stop line. Make firm creases with each fold.



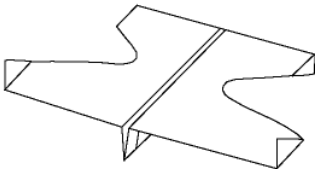
After you reach the stop line, flip your paper over and fold it in half fold line 2, so that the two flat sides of the paper are touching.



Cut along cut line 3 while keeping the paper folded tightly together to ensure that both wings match perfectly.



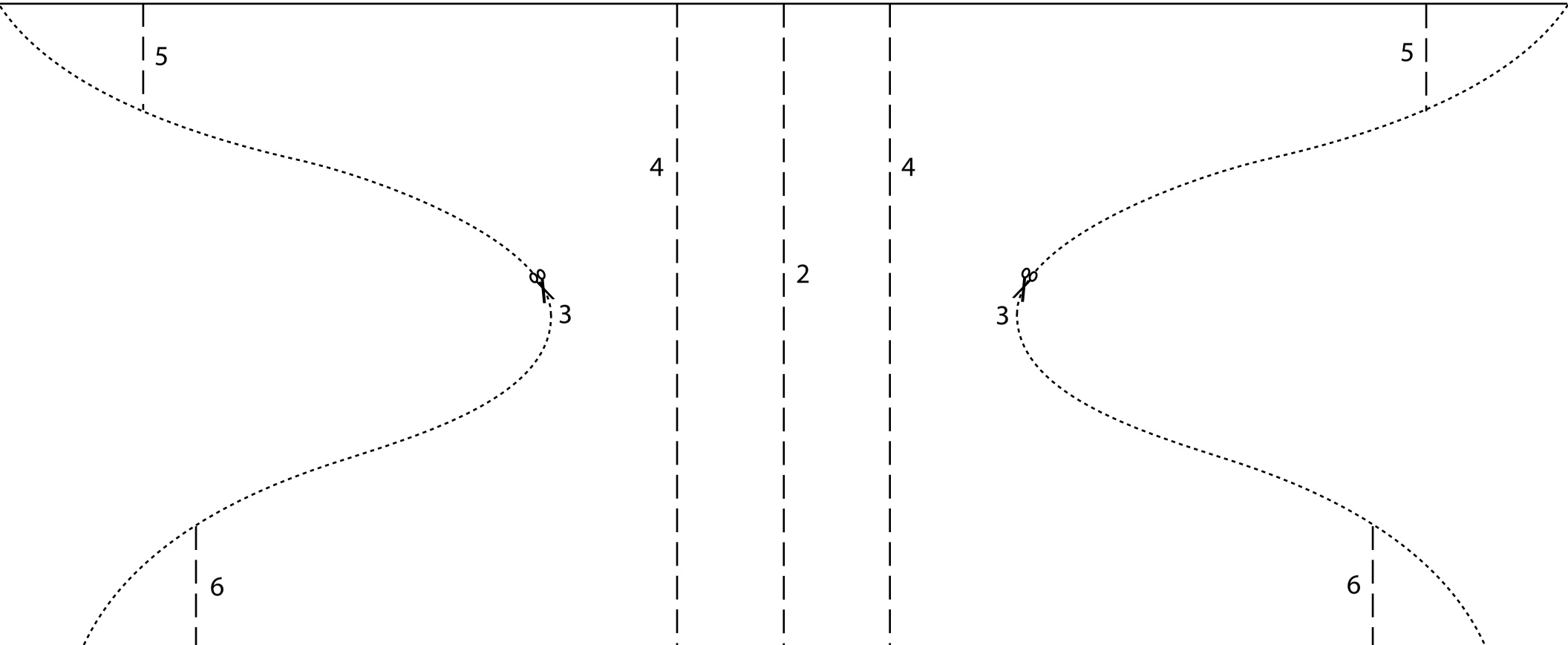
Fold the wings down along fold lines 4.



Fold the front winglets up along fold lines 5 and the back winglets down along fold lines 6. Add wing dihedral by tilting the wings up slightly away from the fuselage. The wings will have a slight "V" shape when viewed from the front. You are ready to fly!

MAKE FIRST FOLD ON THIS LINE 1

STOP FOLDING WHEN YOU REACH THIS LINE



RAPTOR

Launch Instructions:

The best way to fly this plane is to hold it at about ¼ of its length from the nose tip and throw the plane STRAIGHT up with a moderate to small force.

This plane does great in a large open area and/or outdoors. You can adjust the elevator flaps cut in the back so that it will glide down in big lazy circles. Don't expect this plane to fly straight; a RAPTOR design is supposed to fly in circles.

RAPTOR

Launch Instructions:

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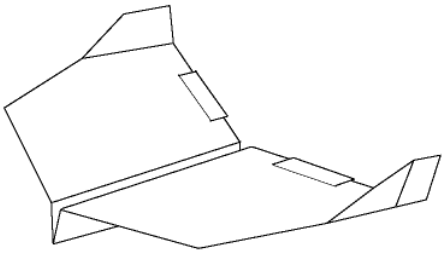
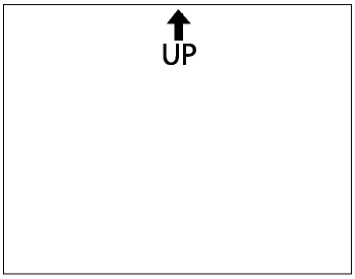
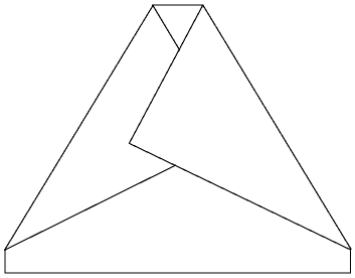
Raptor



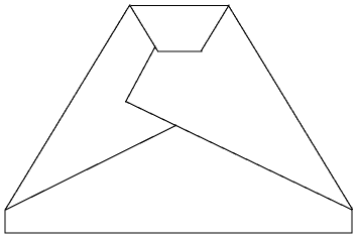
This plane is an excellent outdoor glider. Launch straight up and it will glide down in big lazy circles. Adjust the elevator on the back edge of the wing to perfect the flight characteristics.



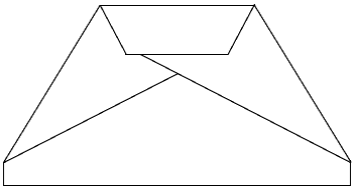
Orient the template so that the "UP" arrow is at the top of the page. Then flip the paper over so that none of the fold lines are showing.



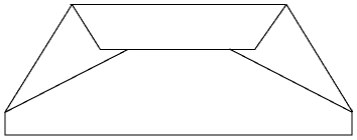
Fold the top right and top left corners in until fold lines 1 appear and crease along the dotted line.



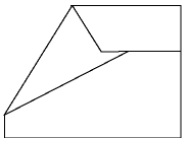
Fold the nose down toward you and crease along fold line 2.



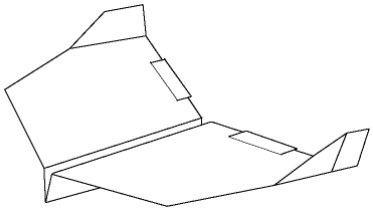
Fold the nose down toward you again and crease along fold line 3.



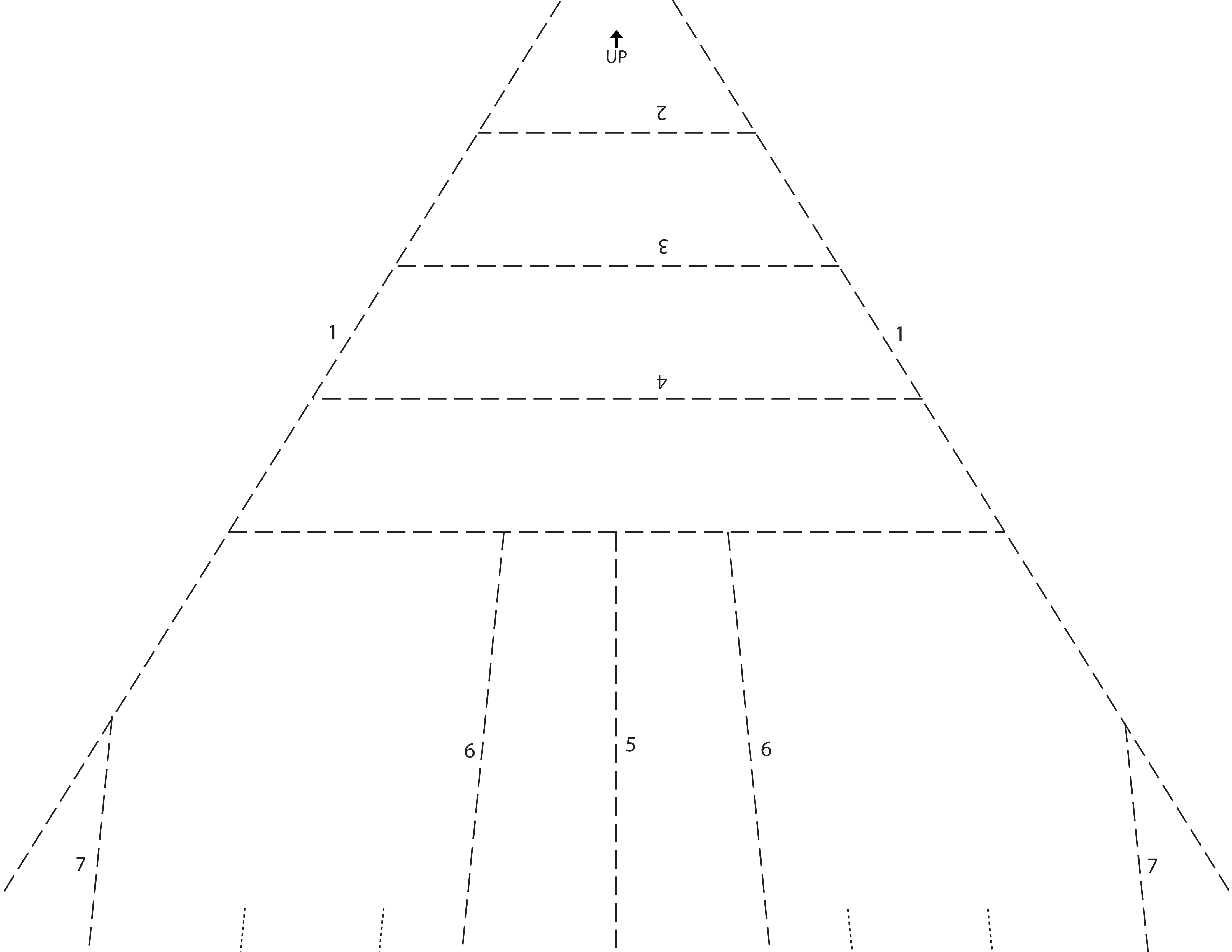
Fold the top edge down toward you again and crease along fold line 4.



Flip the plane over and fold the right half over the left half along fold line 5.



Flip the wings down along fold lines 6 and the winglets up along fold lines 7. Cut slits along the back wing edge for the elevator adjustment. Add wing dihedral by tilting the wings up slightly away from the fuselage. The wings will have a slight "V" shape when viewed from the front. You are ready to fly!


UP
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