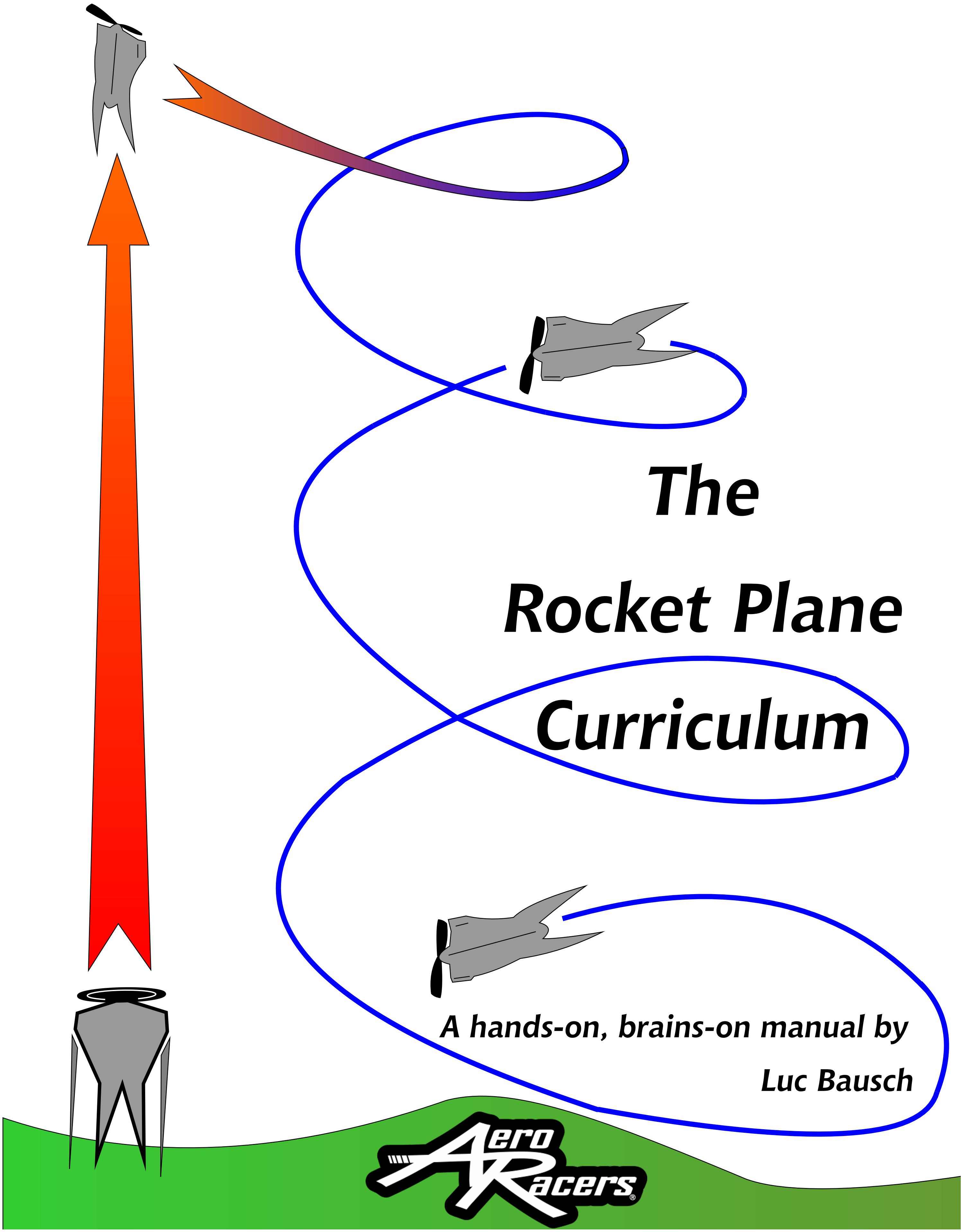
The Rocket Plane Curriculum



A hands-on, brains-on manual by

Luc Bausch

How to Use this Manual:

The Rocket Plane Experience manual should be used in conjunction with any of the AeroRacers "Rocket Planez".

You will build your Rocket Plane as you work through the manual.

There are five lesson plans to guide you through a successful completion of the aircraft as well as learning the basics of rocketry and glider flight.

Before you start, read the aircraft instructions and make sure you have the basic materials needed to build the Rocket Plane.

To build the Rocket Plane, you will need:

A flat space of at least 9 x 12 inches to lay out the wing skin and build the plane

Felt tip markers or crayons

Scissors

Scotch tape or similar

Optional: sheet of white paper

In each lesson plan, use the checkbox to the left of the task to mark that you have completed that task.

Do not rush the building of the aircraft. A well built aircraft will reward you with many long flights.

Let's get started.

Rocket Plane Assembly

Time needed: *Approximately 1 hour 20 minutes*

Materials needed: *AeroRacers Rocket Plane kit, decorating pens, scissors and scotch tape or similar*

Art (1 hour)

☐ *Follow the decorating instructions in the following section and decorate the rocket plane wing prior to assembling the aircraft.*

Technology (20 minutes)

☐ *Follow the detailed rocket plane instructions in the following section and assemble the aircraft.*

Decorating the Rocket Plane Wing Skin

Hand out the rocket plane wing skin to your students. Each student receives one wing skin and one piece of white 8.5 x 11 inch standard paper (if needed per third bullet below).

Before you let them color the wing skins, make sure they understand the following:

- The rocket plane wing skin is translucent. That means that the wing skin is almost see-through and they will be able to see their coloring job as the plane is flying.
- Explain that it is best to use bright and vivid colors for the following reasons:
    1. Bright colors look best in the sky.
    2. Apply the bright colors first, the dark colors last. This prevents smearing and allows students to correct mistakes more easily.
    3. Dark colors can make the stick and tape construction lines disappear or very hard to see. Advise students that if they want to use dark colors not to color over the construction lines during the coloring phase. They can complete their coloring after the aircraft is built. Dark colors also appear as black at a distance in the sky.
- If the building surface where the students will decorate their wing skin is dark, hand out one sheet of standard white paper in addition to the wing skin to each student. Placing the paper underneath the wing skin to be colored lets the student see the line details better. This is also true during the building process.
- We recommend the use of fine tip permanent Sharpies. If you use water based markers, it is best to color both sides of the wing skin to prevent it from warping.

Taking control of the decorating pens.

You can use markers or crayons to decorate the rocket plane wing skins.

Place the pens in a box or similar in the front of the class. Instruct your students that they can come up and pick ONE marker at a time. When they are done decorating with that color, they bring it back and may take another one.

That way you eliminate one student hogging all the "good" colors.

A view of our box of decorating pens that we use during our classes. Notice the variety of colors.

Above you can see a Rocket Planez™ wing skin in the process of being decorated.

Hint: Let your students know that if they color a portion first with grey before coloring it with a bright color, it will give that portion a slightly darker look. The left eyelid of “Happy” has been decorated with grey first, before going over it with yellow. This is a simple way to add additional color tones.

Urge your students to do the best job possible. You can later hold a contest for best decorated rocket plane.

Once students are done coloring, do not let them get ahead by handing out the scissors or additional parts early.

The students that are done early should find another activity for the remainder of the decorating period. If you have a few spare Rocket Planez left, those students could decorate a second “spare” rocket plane that can be used in case one student looses his or her rocket plane later during the flying phase. If you have the students decorate spare rocket planes, you should dictate the decorating pattern as that Rocket Plane could be used by another student. In order to slow them down, tell them what you would like the rocket plane to look like.

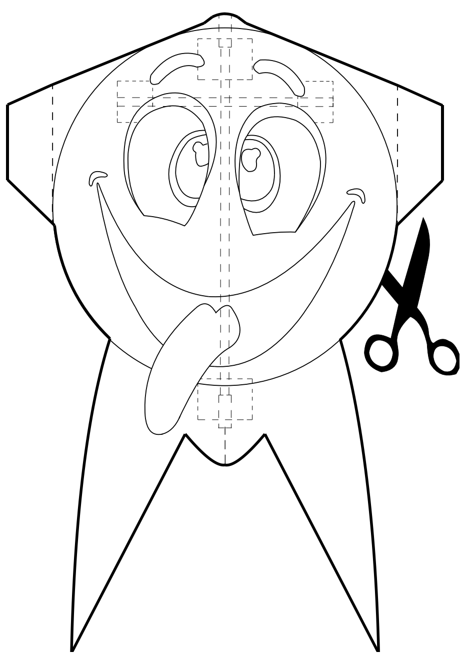
Cutting out the Rocket Plane Wing Skin

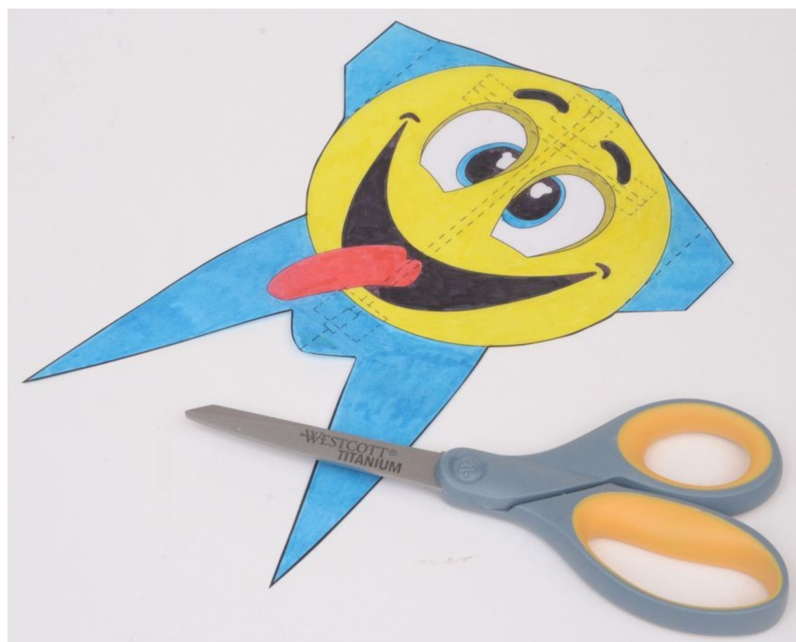
Once all students are done decorating, hand out a pair of scissors to the students. Each student should have their rocket plane wing skin ready to be cut out.

Explain to them that they need to cut slowly and accurately. Accuracy is more important than cutting speed. This is not a race.

Explain to them that they are to cut on the fat black outside line only. This is very important. The shape of the various Rocket Planez can vary, but all students are to cut out their wing shape on the fat black outside line only. Do not cut on the dotted lines.

In case a student has made a mistake, a small piece of tape can be used to tape the mistake cut back together.





As shown above, the wing is cut out on the outside fat black line only. Rocket Planez™shapes vary.

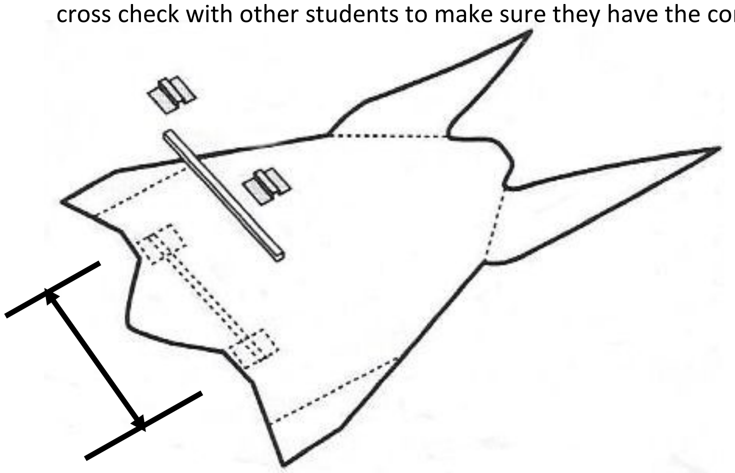
Assembling the Rocket Plane

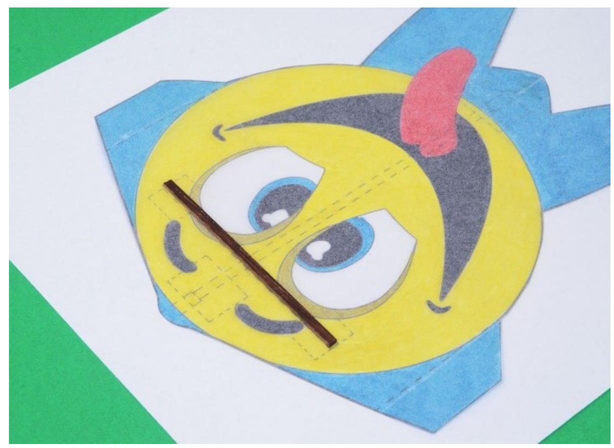
To assemble the rocket plane, make sure each pair of students (maximum group of four students) has a Scotch tape dispenser or similar to share.

Hand out one small stick or wing spar to each student.

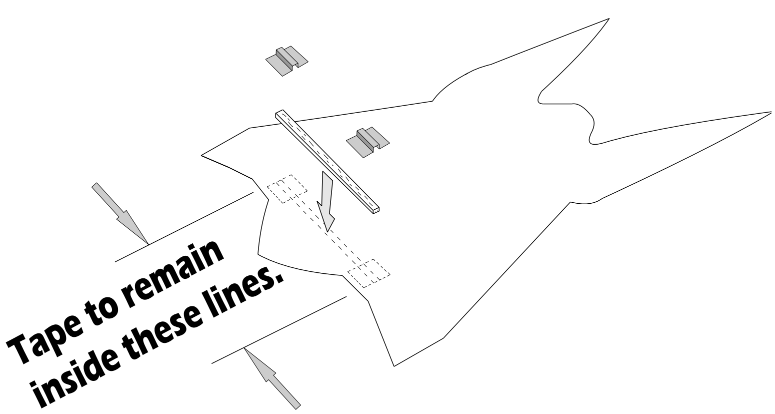
Have the students follow the following steps:

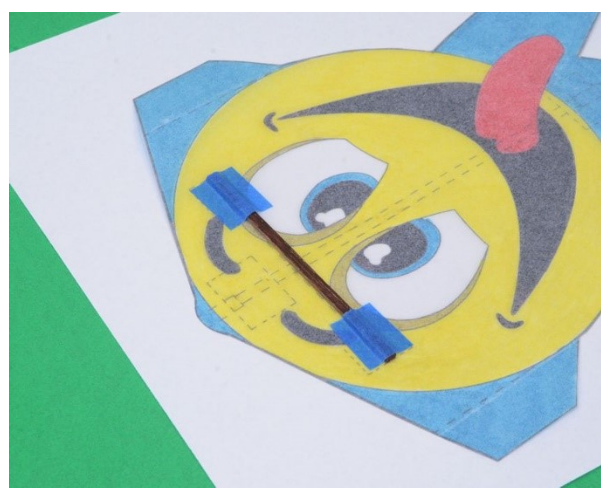
1. Flip their wing skins upside down on the white piece of paper
2. Identify the dotted lines where the small stick known as the wing spar is to be placed
3. Once every student has identified its location they should place the wing spar flat side down over the dotted lines, have them cross check with other students to make sure they have the correct wing spar position





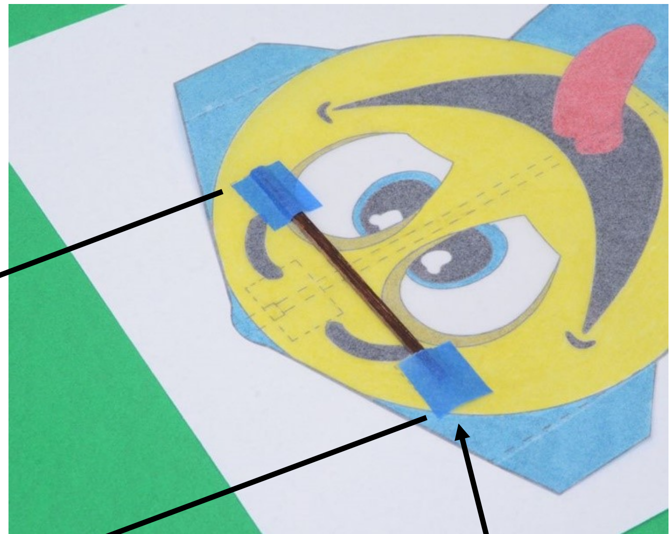
To better illustrate the wing spar position, we colored it brown. Students should be very accurate with the placement of the wing spar. It should be centered so that the wing spar ends do not extend past the end of the tape boxes on both sides.





We use blue tape so you can better see where the tape is to be placed.

Students should get two pieces of tape about .75 to 1 inch long from the tape dispenser. They should hold the wing spar in position and place one piece of tape over the wing spar at each end as shown above. **It is very important that the tape does not extend past the end of the wing spar on either side as shown on the next page.** If the student made a mistake, simply remove the tape and start over.

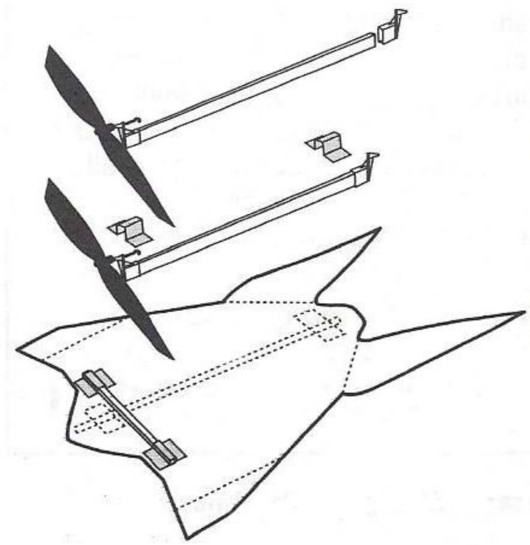


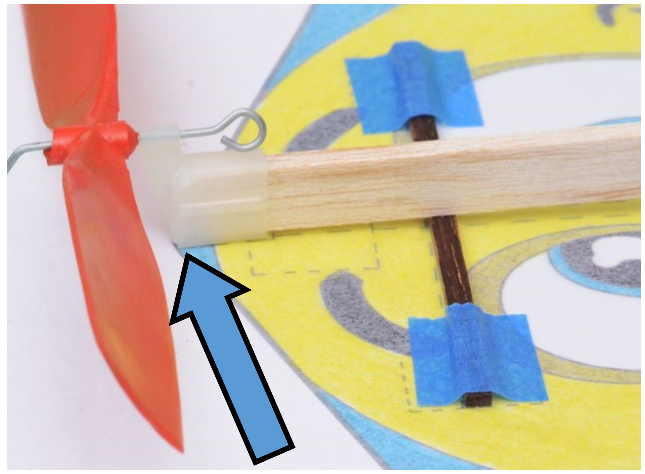
Tape must remain inside these lines for the rocket plane to ascend correctly.

WRONG!

Tape extends past the end of the stick. Remove tape and reapply so that it does not extend past the end of the wing spar stick.

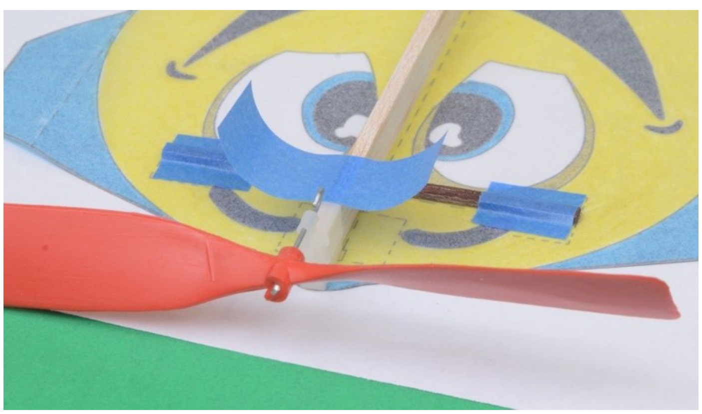
Slide the propeller assembly onto one end and the sleeve (shown in yellow here) onto the other end of the motor stick as shown above.

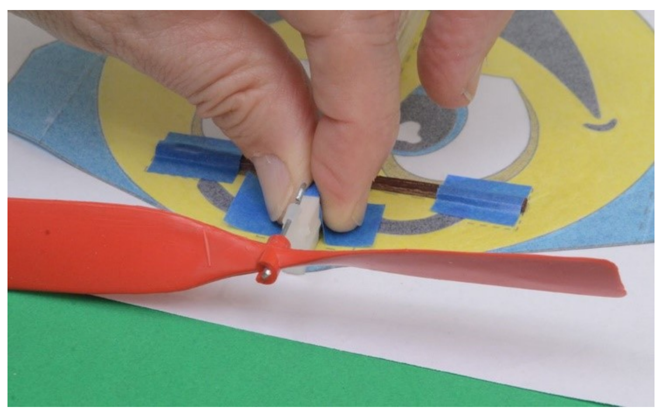




Place the motor stick upright so that the front end of the propeller sleeve is flush with the front of the wing skin as shown above with the blue arrow.

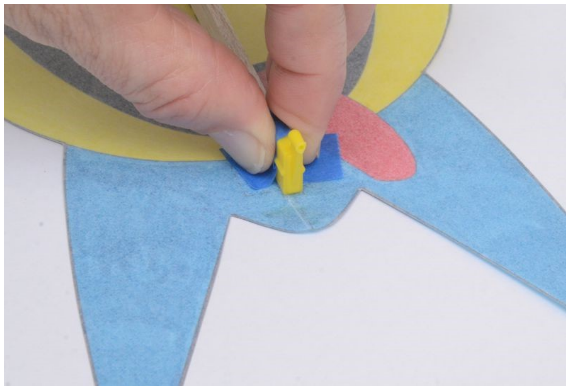
The students should get two pieces of tape about 2 inches each in length. They should tape the front end of the motor stick first to the wing skin where indicated by dotted lines down the middle of the wing skin (see above left) on the wing skin. It is a good idea to place the tape such that it goes a little over the plastic propeller sleeve.

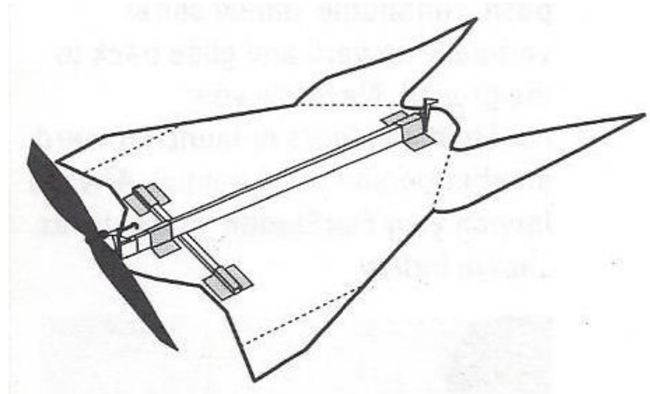




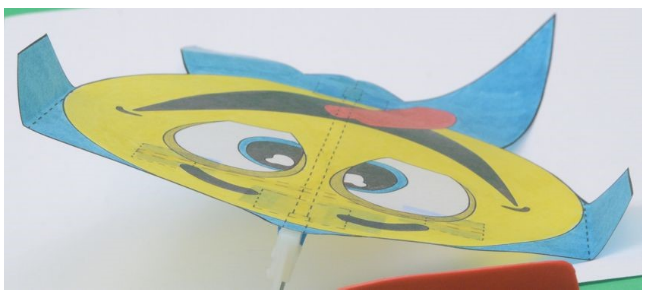
Attach the piece of tape over the motor stick and propeller sleeve in the front as shown above to the left.

Use your thumb and index finger to "glide" down both sides of the motor stick over the tape as shown above to the right. Finally, make sure that the tape is well secured to the motor stick and the wing skin. If you make a mistake or you do not like your taping job, slowly remove the tape and try again.

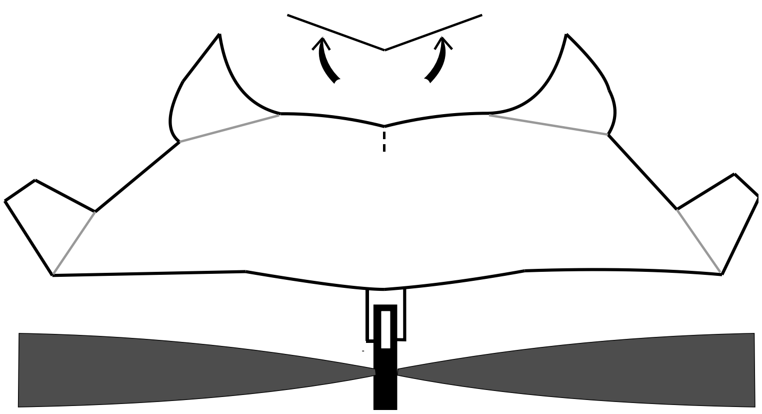




Using the second piece of tape about 2 inches in length, repeat the same with the back of the motor stick assembly, placing the tape such that it goes a little over the plastic sleeve. Make sure the motor stick is centered on the wing skin.



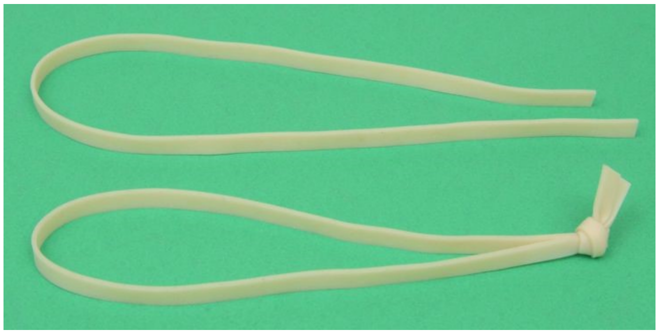
Fold the wing tips on the dotted lines up to no more than 90 degrees. Both wing tips should feature about the same angle when you are done.



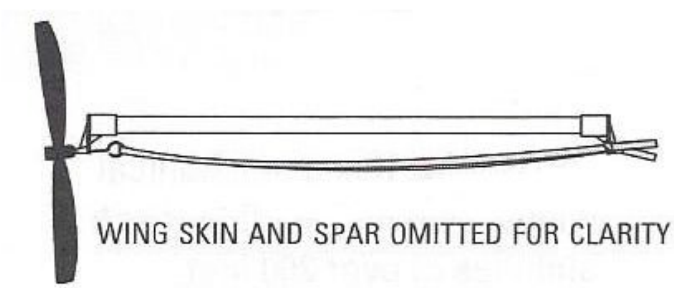
The tail pinch is very important to add to your rocket plane.

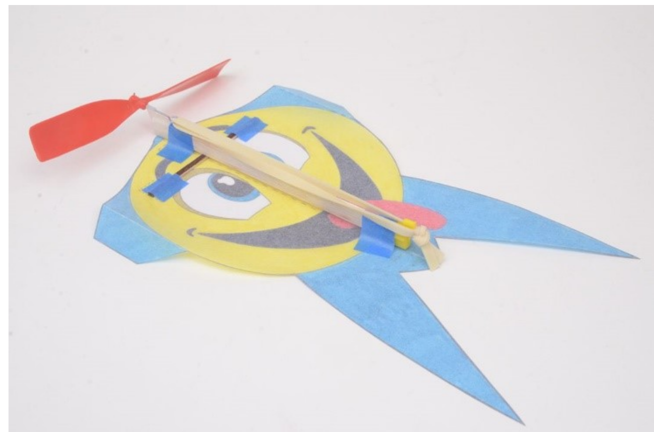
To add glide stability to your rocket plane, form the paper to a slight positive (up) V shape behind the end of the motor stick. Simply pinch the paper between your thumb and index finger as shown.

When you release the paper, the tail end should show a slight up “V” shape as shown to the left above.



Fold the rubber string in half and tie a knot at the end to form a loop. Make the knot as close to the end as possible.





Slide the rubber motor into the propeller shaft opening. Loop the knot around the sleeve as shown.

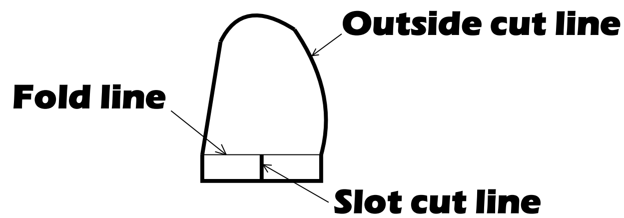
Congratulations!

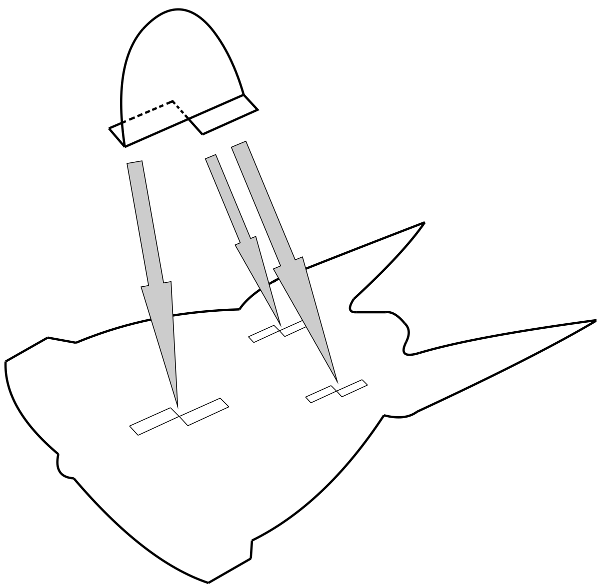
Your rocket plane is now ready to fly.

3D Model Instructions

If your rocket plane is of the 3D type and ready to fly, you can now add the extra parts like vertical stabilizers. You can fly your rocket plane with or without those extra parts.

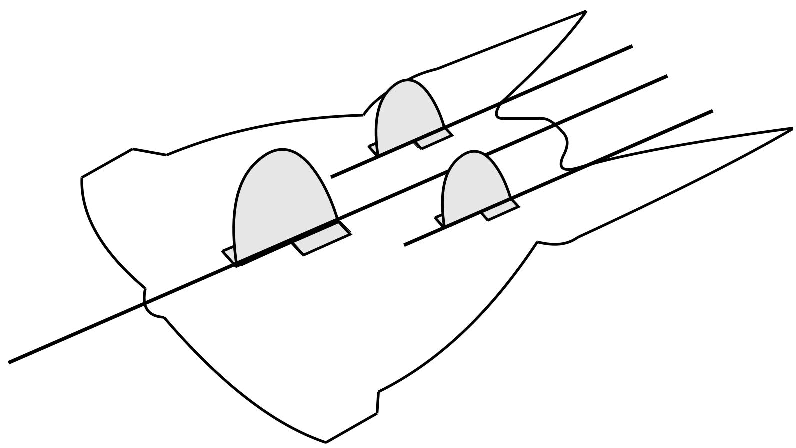
1 Use scissors to carefully cut out the optional parts along the thick outside line. In addition, cut in the slot as indicated by the fat line on the optional part. DO NOT cut on the fold line





2 Fold the two base parts apart on the fold line. One part goes to the left, the other one to the right as shown.

Find the double rectangle(s) on your rocket plane which indicate the location of the optional part(s).



3 Use small (as small as possible) pieces of tape to tape the optional shape(s) to the top of your rocket plane wing.

It is very important to make sure that your optional shape(s) are lined up straight with or parallel to the centerline of your rocket plane.

4 Bend the optional shape(s) back and forth a few time to make sure that the wind can easily bend them during the ascend portion of the flight.

If you rocket plane does not ascend correctly, remove the optional shape(s) and fly it without. If your rocket plane flies fine without the optional shapes it means that you did not install the shapes correctly. Try again and pay attention to using as little tape as possible and make sure the shape(s) is in line with the rocket plane center line or parallel to the center line.

About Vertical Ascent, Glide Recovery, Thermals and Glide Ratio

Time needed: *Approximately 1 hour*

Materials needed: *Completed AeroRacers Rocket Plane. Measuring stick or tape, pencil and paper. A calculator comes in handy as well.*

Science (20 minutes)

☐ *Start by reading the section on the rocket plane. Make sure you understand how the rocket plane ascends vertically and then transitions into the gliding descent.*

☐ *Read the section on Thermals. Can you think of places around your area that could produce thermals? Think about why birds are circling in the air and rising without flapping their wings!*

Science (20 minutes)

☐ *Read the section on the tail adjustment of the rocket plane.*

☐ *Read and understand how to recognize a nose/tail heavy glider and how to fix it.*

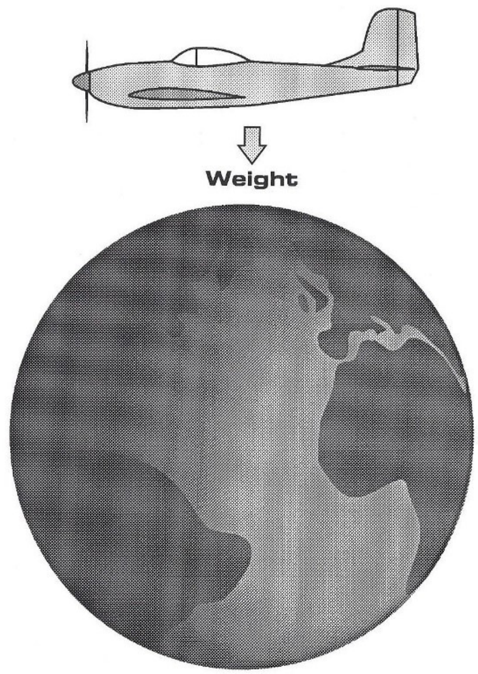
Science (20 minutes)

☐ *Read the section on Glide Ratio. Make sure you understand how glide ratio is calculated.*

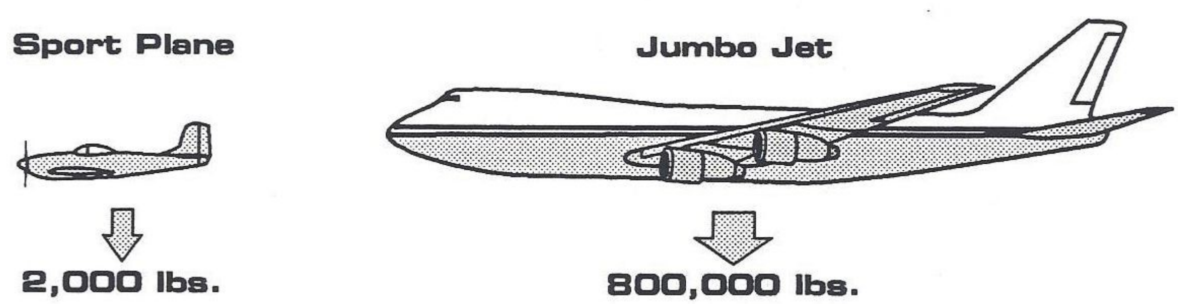
☐ *Understand that the glide ratio number represents the glide performance of the aircraft. The higher the glide ratio, the longer and further the glider can fly.*

Weight

Weight is caused by gravity. Gravity pulls an aircraft towards the ground.

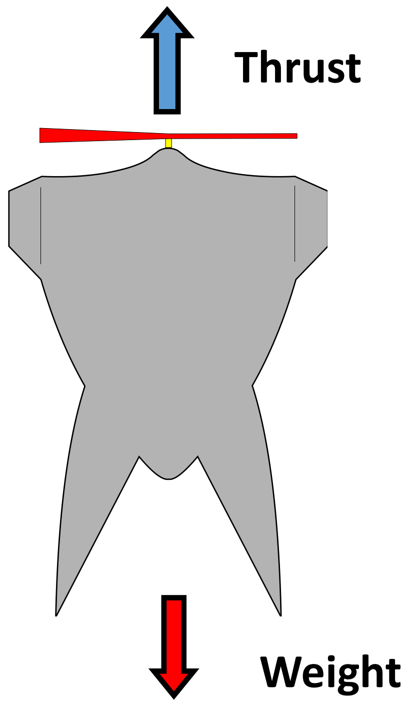


The weight of an airplane can vary. A small, single-engine, sport plane can carry 4 people and weigh nearly 2,000 pounds. A Jumbo Jet that is fully loaded can carry 360 passengers and weigh nearly 800,000 pounds!

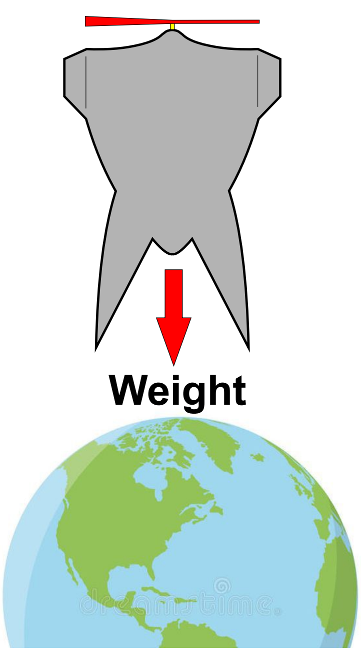


It is a good idea to keep your Rocket Plane as light as possible. Since your airplane is powered by a rubber band that can only produce a small amount of power, it is best to keep the overall weight of the airplane low. You can keep your airplane light by not using excessive tape and using markers instead of paint to color your aircraft.

Thrust



Thrust *is the force that moves an airplane forward. Powered airplanes move through the air by means of an engine. Propeller planes have engines that turn the propellers. Jet planes and rockets have engines which produce powerful streams of air and gases. These streams of air come out of the exhaust nozzle and propel the airplane forward. Both propeller and jet planes have engines which generate thrust. Whenever we refer to thrust, we will indicate it with an arrow pointing forward. In our case the force arrow for Thrust generated is shown upward because our Rocket Plane launches straight up and travels vertically towards the sky while under power.*

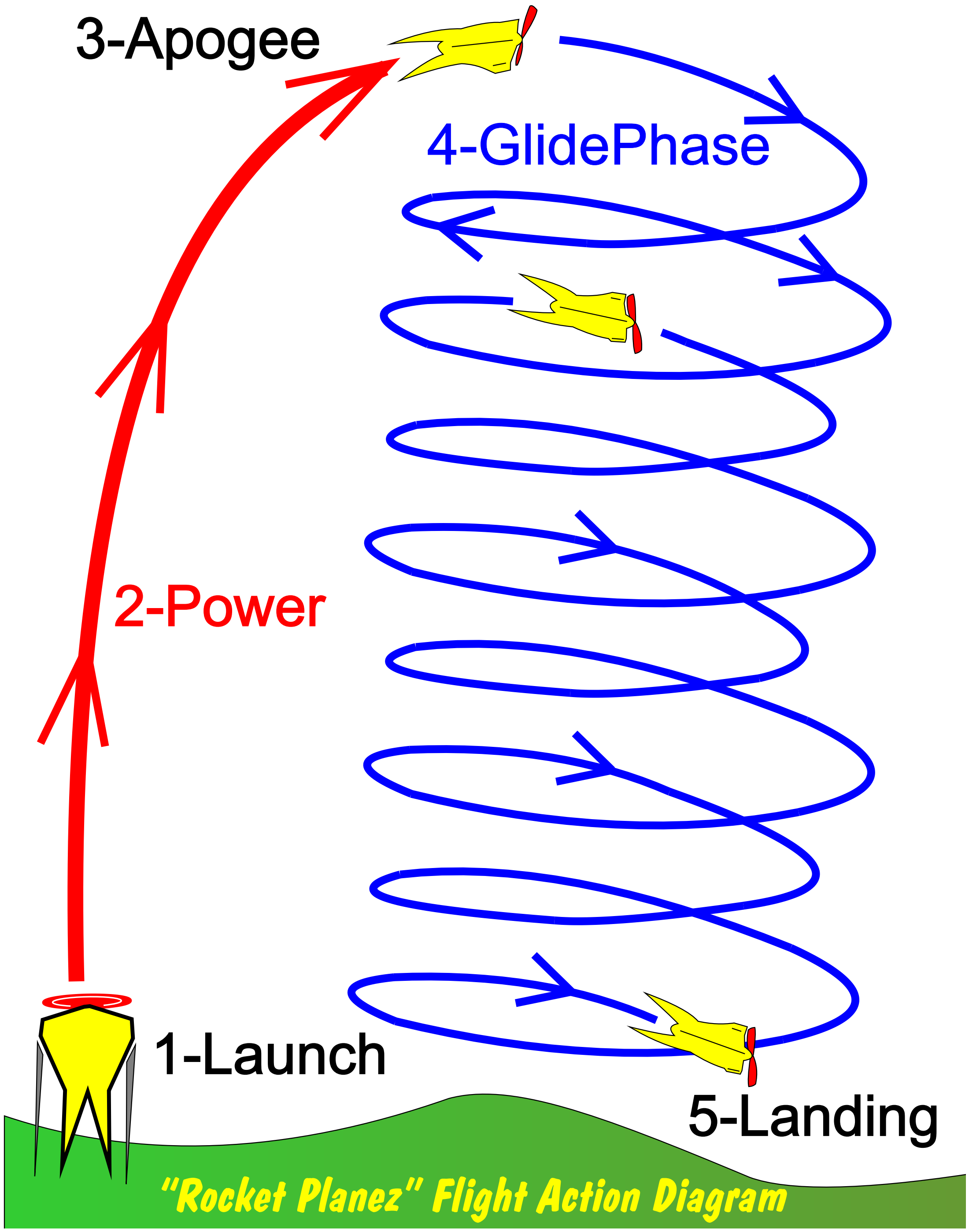


As our Rocket Plane will ascend vertically, the propeller needs to produce enough thrust to overcome the weight of the Rocket Plane (about .3 oz or 8 grams ready to fly) and accelerate it towards space.

Since our Rocket Plane is powered by rubber band, it is easy to understand that maximum Thrust produced by the rubber band is right at launch when the rubber motor is tightly wound. As the Rocket Plane ascends, it will gradually produce less and less Thrust as the rubber motor unwinds.

The rubber motor will eventually not have enough winds left for the propeller to produce enough Thrust to sustain the climb. At this point the Rocket Plane will stop climbing and when the propeller stops turning, it will transition into the glide mode to safely descend back to earth.

The Flight Phases or our Rocket Plane.



1-Launch: *The rocket plane is launched vertically.*

2-Power Phase: *The rocket plane ascends towards the sky under high power (150 winds or more).*

3-Apogee: *The rocket plane has reached its highest altitude as it runs out of power.*

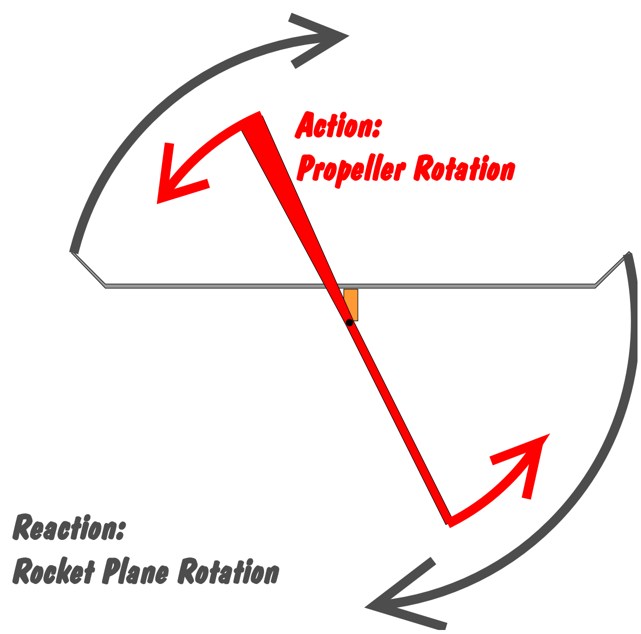
4-Glide Phase: *The rocket plane turns into a glider and glides towards the ground.*

5-Landing: *The rocket plane lands safely, ready for the next flight.*

Rotation during the ascent

Your Rocket Plane is designed to rotate during the ascent. This is a reaction to the propeller turning in one direction and the aircraft wanting to turn in the opposite direction. To check out this rotating phenomenon, wind your Rocket Plane a little, hold on to the propeller and let go of the body. You can see that the body is trying to rotate.

Newton's Third Law *says that for every action, there is an equal and opposite reaction. In our case, the action is that the propeller unwinds counter-clockwise as seen from the front. The reaction is for the whole Rocket Plane wing to spin in the other direction. Your Rocket Plane is specifically designed to spin as it ascends vertically. The spinning motion of the entire Rocket Plane is what keeps the aircraft going straight up. The spinning motion is a flight stabilizer. The stabilizing force produced by the spinning aircraft is called the* **centrifugal force**.



Rocket Plane seen from the front to illustrate Newton's 3rd law acting on the aircraft.

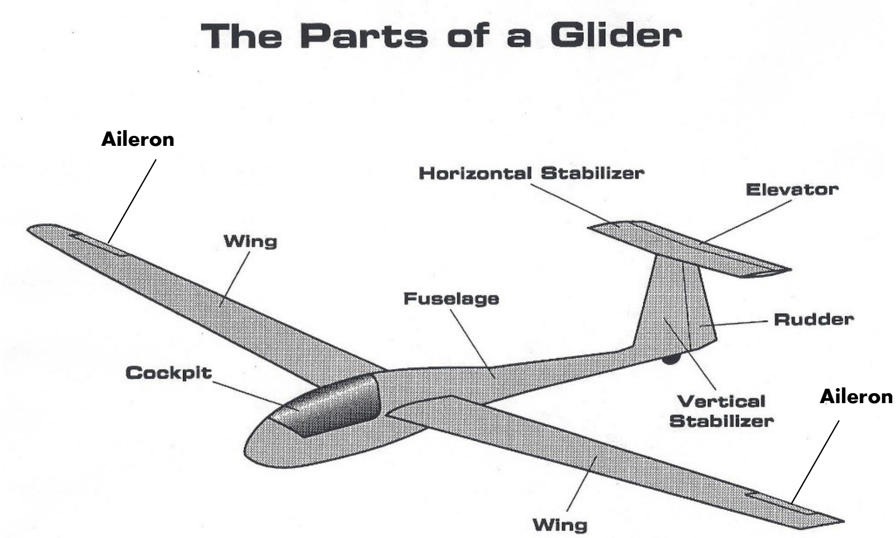
The Glide Phase

The moment the propeller stops turning and no longer produces thrust, the Rocket Plane becomes a glider. A glider is a type of aircraft that is powered by gravity. A full sized manned glider can ride wind currents and can fly for many hundreds of miles when flown by a skilled pilot.

A modern glider in flight. Such a glider can have a glide ratio of 60:1. That means that for each mile of altitude (height) it has above ground, it can theoretically fly a distance of 60 miles before it lands (assuming no thermals or downdrafts).

The Glider

Before we go any further, let us examine a glider.



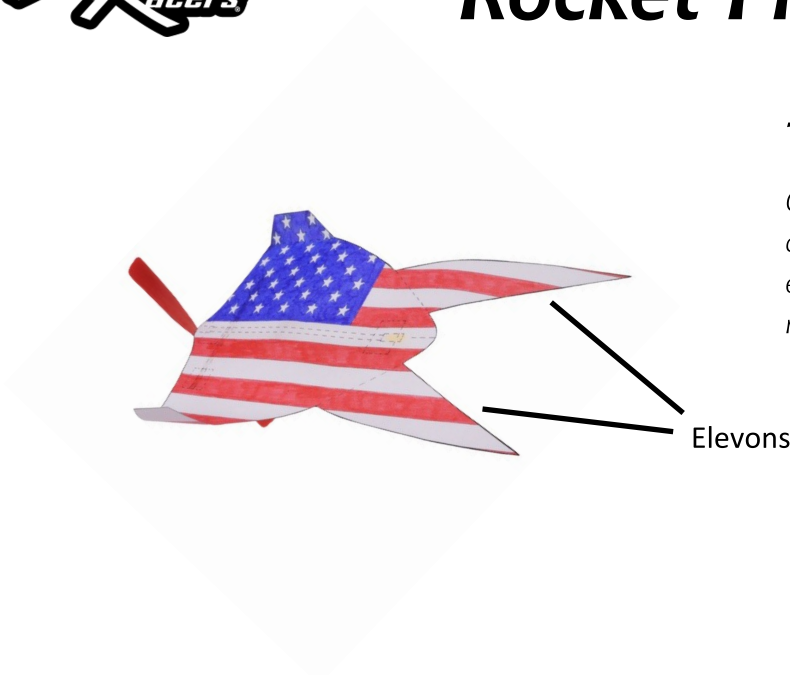
A glider or sailplane consists of mainly three main parts: the fuselage, the wings and the tail.

The fuselage is the part of the glider to which the wings and tail unit is attached. The fuselage also houses the cockpit where the pilot sits to control the glider.

The wings provide the necessary lift for the glider to make long, graceful flights.

The tail section or empennage help the glider fly straight through the air, similar to tail feathers on an arrow. The rudder, elevator and aileron portions are moveable and are used by the pilot to guide the glider.

A very well known example of a glider is the Space Shuttle.



The Flying Wing

Our Rocket Plane does not have a fuselage and hence is called a flying wing. Instead of ailerons and elevator, two elevons provide the necessary flight controls for pitch and roll. The two tails on our Rocket Plane act as the elevons.

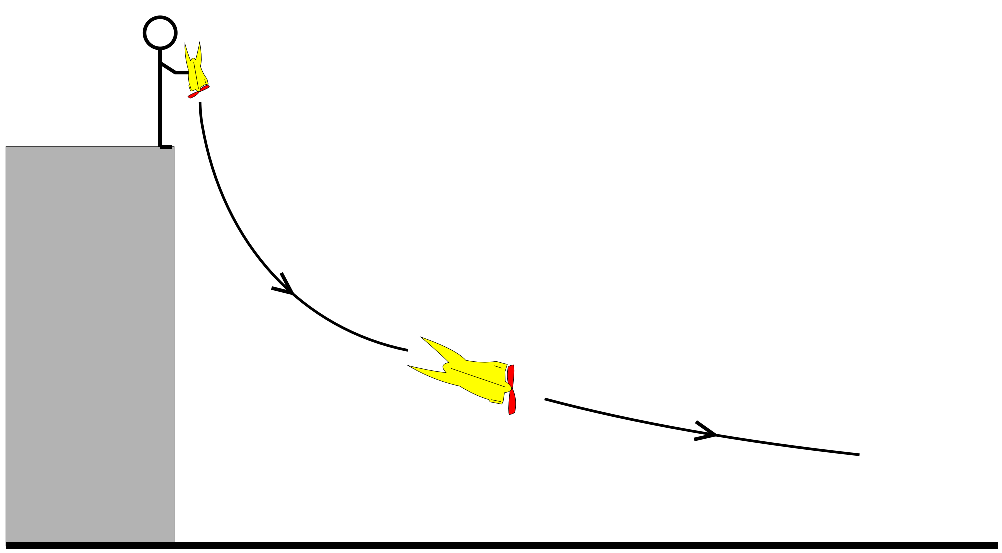
Gliders and Thrust

A glider flies like a soaring bird. It has to move forward in order to fly. We all have observed birds soar through the air without flapping their wings. The glider flies as gracefully as soaring birds do.

When a powered aircraft like a sport plane loses engine power and the engine no longer produces the necessary thrust for level flight, the powered aircraft becomes a glider. The pilot will trim his/her aircraft to glide at a safe speed and looks for a place to land.

Since a glider has no engine, a force moving the glider forward similar to a powered airplane has to exist for the glider to fly. This force is called gravity.

Gravity *is the force that enables a glider to fly. If you were to drop your Rocket Plane motor stick with the propeller from a roof top, it will fall straight to the ground and crash. If, however, you let go of the completed Rocket Plane from a rooftop without winding the rubber motor, it will start flying after some drop. The reason is that as air flows over the wings, the wings start producing lift and the glider flies.*



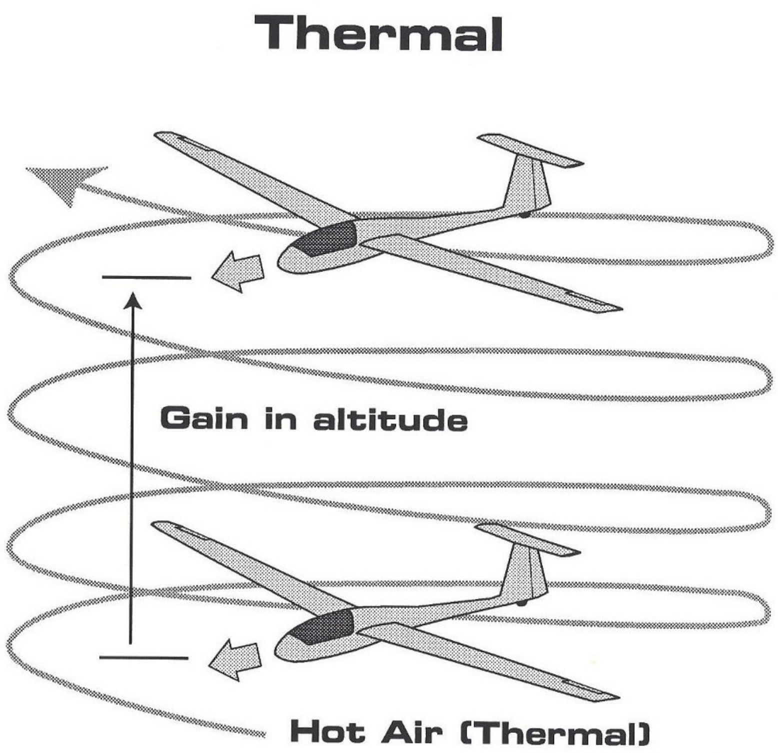
Thermals

We also observe birds circling in the air and rising at the same time. This is an indication that they have found pockets of warm, rising air. These pockets of warm air are called thermals. As long as the birds can circle in the hot air pockets, they will continue to rise without flapping their wings.

A glider can also rise when circling in a thermal or hot air pocket. In a real glider an instrument alerts the pilot if he/she is in a thermal. This instrument is called a variometer. The pilot will then begin to circle and the plane will climb higher within the thermal. If our model glider enters a thermal, it usually indicates it by rocking its wings.

Thermals occur mostly in the late morning till mid afternoon. The sun has to warm up the ground first. Once the ground is heated up it radiates heat and heats the air close to the ground just like a conventional oven. We all know that hot air rises (think of a hot air balloon). Hot air can easily rise to altitudes of 15,000 feet or more.

So how does a glider use a thermal to gain in altitude. We have to do a little math for this one.



We now know that a glider flies normally towards the ground. Let us assume the glider has an average glide ratio of 60:1 and using its best gliding speed (the speed at which the glider flies the longest distance while losing the least amount of altitude), it loses 1 foot in altitude for each second that it glides. So in a minute, our glider will loose 60 feet of altitude.

The hot air in the thermal rises into the sky at 10 feet per second. If our glider flies in that thermal it will net a gain in altitude of 9 feet per second.

Hot air upward speed - glider downward speed = Net gain in altitude per second of flight

In our case:

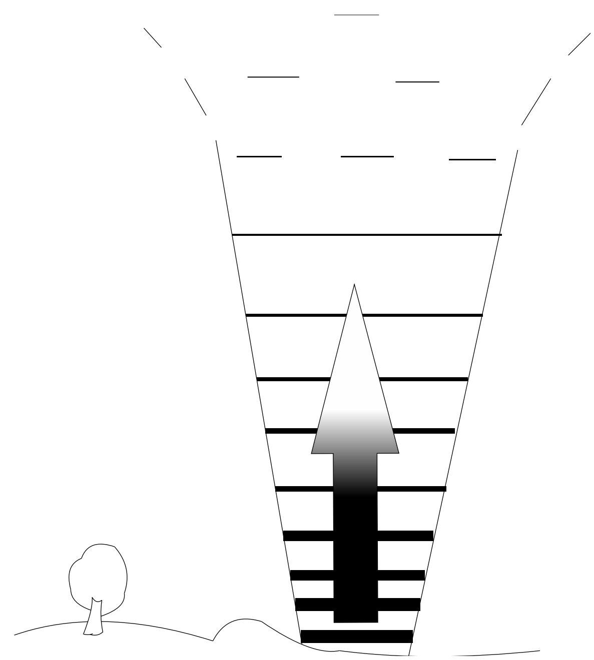
10 ft/sec - 1 ft/sec = 9 ft/sec net gain

The glider can rise as much a 9 feet in one second if it manages to stay in the thermal.

Thermals have more hot air closer to the ground than at high altitude. Since the air surrounding the thermal is cooling the thermal air constantly as it rises, the thermal is less potent towards the top.

Once the glider reaches the top of the thermal there is no more gain in altitude and the glider pilot has to search for another thermal.

A good glider pilot looks at the ground and can find places where thermals might originate. Parking lots, streets and rocks are good places that can store heat from the sun and release it when the surrounding air cools down. There are not many thermals rising from grassy fields as the grass keeps the ground cool.



Hot air in thermal is less potent towards the top.

When you fly your AeroRacers Rocket Plane later on, it is a good idea to fly on a grassy field because grass is an excellent surface for your aircraft to experience some rough landings without sustaining damage.

You will notice that your Rocket Plane will catch some thermals especially when it flies over hard surfaces like baseball diamonds or parking lots. Any hard surface in the area has the potential to provide your glider with a thermal and it will gain some altitude or slow the descent.

Use the elevons to make your aircraft fly in a wide shallow circle. That way it has a chance of staying in the thermal. Remember, thermals are mostly circular in shape and become wider as they rise.

Lesson Plan 3 Rocket Planez™

Center of Gravity, Test Flying, Glide Patterns and Glide Ratio

Time needed: *See below for individual flight tests and engineering calculations.*

Materials needed: *Completed AeroRacers Rocket Plane. Measuring stick or tape, pencil and paper. A calculator comes in handy as well.*

Science (20 minutes)

☐ *Read the complete lesson. Make sure you recognize the different glide patterns.*

Technology (20 minutes)

☐ *Test glide your Rocket Plane to find the optimal elevon position for best flight performance.*

Engineering (30 minutes)

☐ *Test glide your Rocket Plane and calculate its glide ratio.*

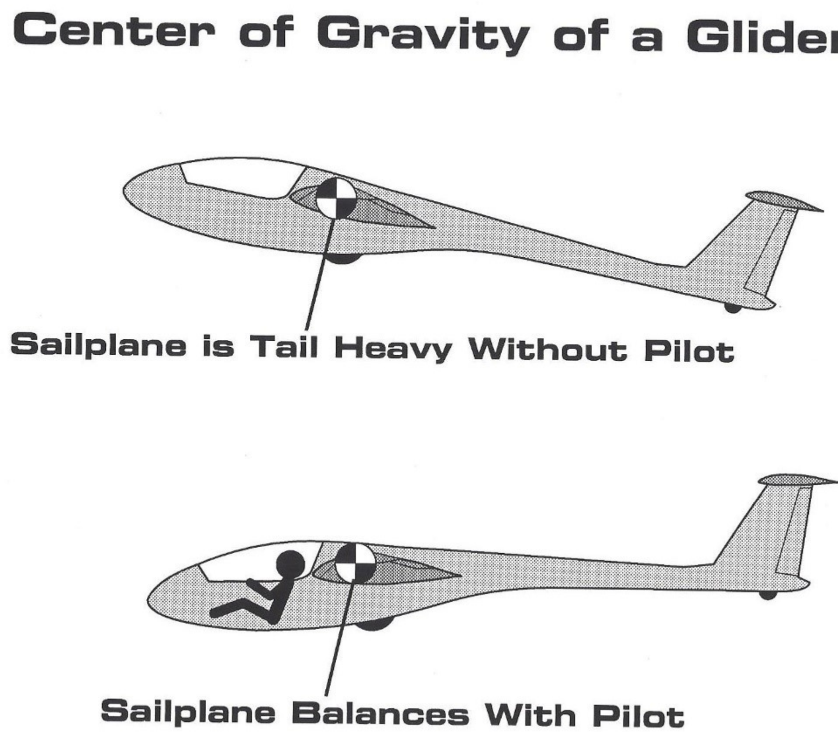
Math (20 minutes)

☐ *Calculate the distance in miles that your rocket plane would fly if you were to launch it from the top of Mount Everest.*

Center Of Gravity

Before we get to flying our glider in a thermal, we have to make sure it is balanced correctly for flight.

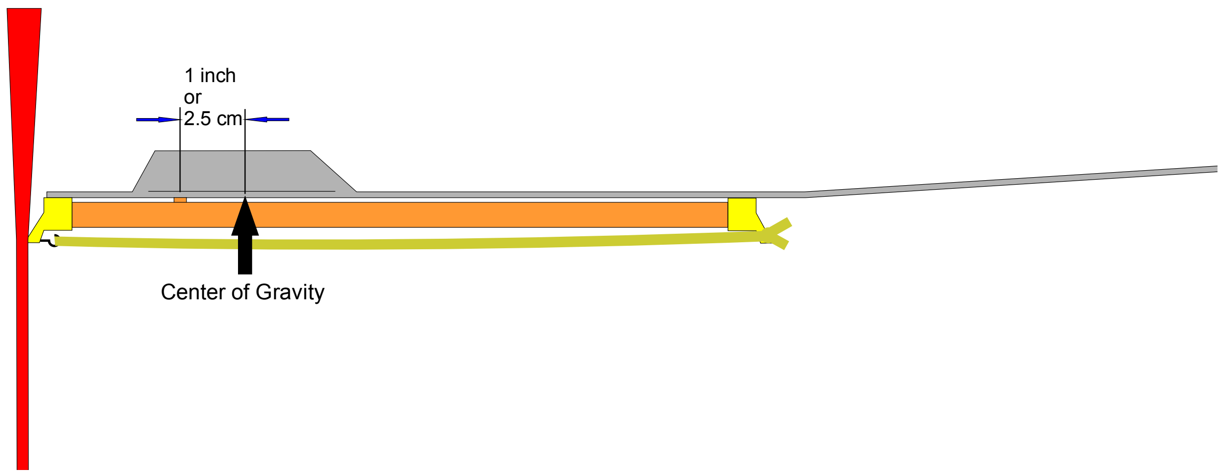
When we look at a glider or sailplane, the center of gravity is in a similar location on the wing compared to a powered plane. A real glider cannot balance without a pilot. Since gliders do not have an engine in the front to counter-balance the weight of the tail, the pilot acts as the balancing weight. This is why glider cockpits are always in the front of the fuselage.



Gliders are designed for average pilot weights. If a lower than average weight pilot flies the plane, weight must be added to the aircraft in the cockpit area in order to balance it. This added weight is called ballast. The weight limits are indicated in the cockpit of the glider. If the pilot's weight exceeds the weight limit, he/she cannot fly the glider.

The Importance of the Center of Gravity on a Model aircraft

Model gliders must balance according to the building instructions. On our Rocket Plane, the center of gravity is located 1 inch or 2.5 cm behind the main wing spar. Simply form a cradle with your thumb and index finger and place the aircraft at the center of gravity location onto the thumb and finger tips. It should balance with its nose slightly down.

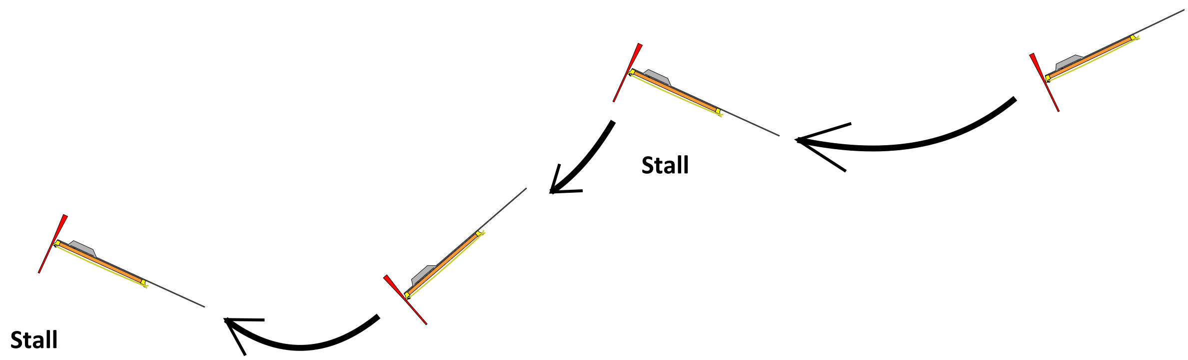


If our rocket plane does not balance exactly as shown above, do not worry as it is designed to fly even if the center of gravity is far off ideal.

We will not add ballast to get the center of gravity right on, even if the plane is nose or tail heavy. The reason for this is that we do not want to add weight to our rocket plane as extra weight will drastically affect the altitude reached while flying under power.

We will simply observe the glide path of our rocket plane and use the elevons to adjust the glide.

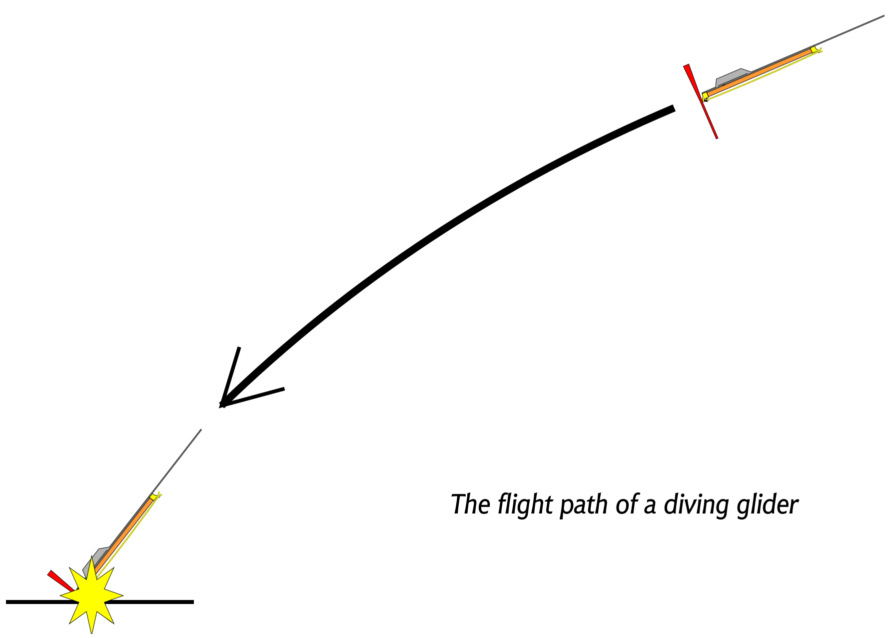
The first time you fly your Rocket Plane, choose a fairly calm day. Observe the glide descent of your aircraft. It your Rocket Plane glides in a wavy, up-down, up-down pattern, that means your wing is stalling (stops flying).



The flight path of a flying wing glider that is stalling

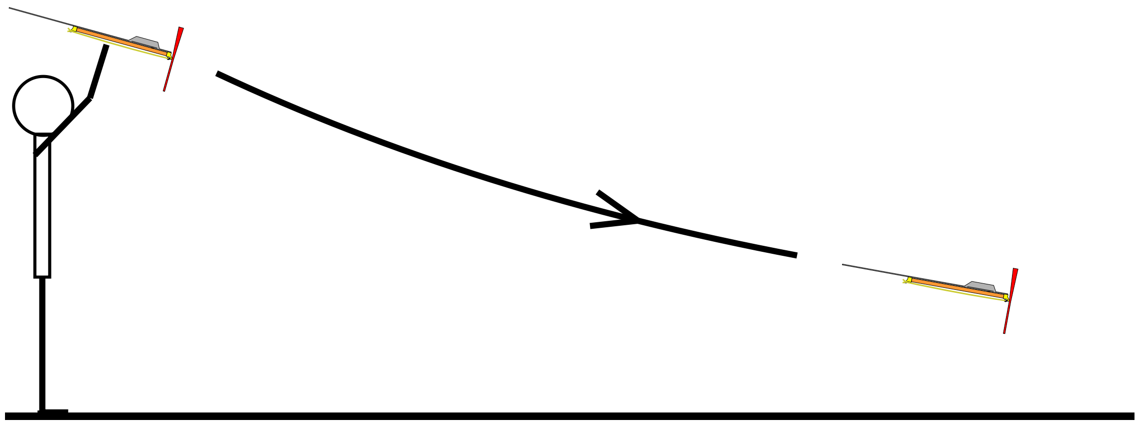
As your glider raises its nose it runs out of flying speed and it slows down until it stops flying. This is called a "Stall" in aviation. The glider now has to drop the nose again to gather up flying speed only to stall again a little time later. It will keep stalling until it hits the ground.

To remedy the stalling on the Rocket Plane, bend both elevon tabs down a little.



The flight path of a diving glider

If your Rocket Plane is diving, it will land at high speed after a short flight. You need to bend both elevons up a little.



The glide path of an AeroRacers Rocket Plane

Our rocket plane likes to glide fairly fast. It even glides well in windy conditions, which is not the case for conventional aircraft.

Glide Ratio

Glider performance is indicated by glide ratio. Let's just say a glider has a glide ratio of 10:1. Let's use feet as our unit of measure. As our glider looses one foot in altitude, the glider flies forward 10 feet.

Now, let's use a mile as our unit of measure. Assuming no wind or thermals, if the glider with a 10:1 glide ratio starts at one mile of altitude, it will glide for 10 miles before it lands.

1 mile x 10 = 10 miles

Modern full scale gliders can have glide ratios of 60:1. Imagine how far they can glide if a thermal takes them to an altitude of 2 miles above the ground. Yes, you are right, that is a gliding distance of 120 miles.

2 miles x 60 = 120 miles

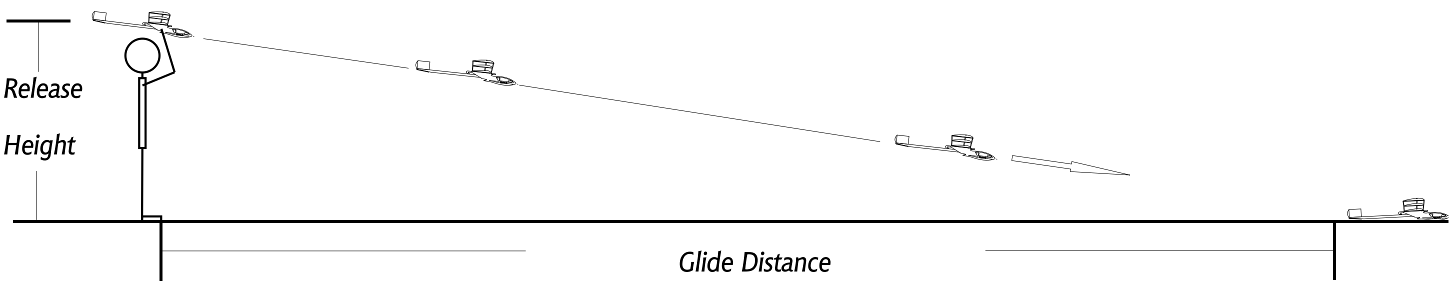
How far would our AeroRacers glider fly if we hand-launched it from the worlds highest point, Mount Everest at 29,035 feet above sea level? We of course have to assume very calm conditions. Let's find out.

Calculating the glide ratio of your glider

You will need: your rocket plane, a larger empty space, a measuring tape, a calculator, a note pad and a pen or pencil.

To calculate the glide ratio of your glider, you first need to make sure it is well balanced. Choose a non windy area such as a gymnasium or cafeteria to fly your tests.

Hand-launch your glider several times to make sure it glides the longest distance. After you are satisfied with the glide performance, measure the height from which you release your glider. This is easily done by standing along a wall and marking the release height on the wall with a pencil. Measure the release height accurately.



Now measure the distance the glider flies from where you stand to where it touches the ground first. Fly several tests and calculate the distance flown by using the average distance of the three longest flights (add the three longest flight distances together and divide by three to get the average longest distance flown).

Make sure you measure both release height and glide distance in the same units. If you use feet for the release height, you have to measure the glide distance in feet.

Calculate the glide ratio of your glider by dividing the glide distance by the release height:

Glide Distance / Release Height = Glide Ratio

Example:

Assume your glider flew an average glide distance of 15 feet. Your release height is 5 feet.

The glide ratio of that glider is:

15 / 5 = 3

That glider has a glide ratio of 3 (3:1). This means that for every foot it looses in altitude, it travels a distance of three feet over the ground.

Launching from Mount Everest

Now that you have calculated the glide ratio of your glider, let's see how far it would fly if you launched it from the very top of Mount Everest.

Mount Everest has a maximum height of 29,035 feet. Let's assume you are 6 feet tall and hold your glider above your head to launch it. This will add seven feet to the Mount Everest height as far as release height above sea level is concerned. Assume the glider will fly until it reaches sea level. How many feet will it travel before it touches down?

Take the glide ratio of your glider and multiply in by the calculated launch height in feet. Now you know the distance in feet your glider will fly (assuming optimal conditions) launched by you from Mount Everest.

Calculation:

Total release height above sea level:

Mountain top height + Person Release Height = Total Release Height

29,035 feet + 7 feet = 29,042 feet

You recall the glider only has a glide ratio of 3 or 3:1

That glider will travel the following distance before it lands:

29,042 x 3 = 87,126 feet

Let's convert that to miles so it is easier to understand. One mile has 5280 feet. To get the result in miles, divide the result in feet by 5280.

87,126 / 5280 = 16.50 miles

That glider would fly 16.50 miles before touching the ground. That is quite impressive. I wonder how far your rocket plane would fly from Mount Everest? Keep in mind that you would launch it fully wound it would it at least climb to 100 ft above Mount Everest.

Perform the calculation and find out….

Beauty Pageant, Launching Your Rocket Plane and Flight Competitions.

Time needed: At least 1 hour

Materials needed: AeroRacers Rocket Plane ready to fly

Rocket Plane Beauty Pageant (20 min)

☐ *Line up the rocket planes and let the students pick the best decorated rocket plane. Award points for first through third place.*

Safety

☐ *We recommend having all astronauts wear safety glasses while winding and launching their rocket planes.*

Powered Flight Fun (as long as you dare)

☐ *Learn how to launch your rocket plane correctly and safely. Learn how to perform a pre-flight wind check.*

- ☐ *Which direction is the wind coming from?*
- ☐ *Am I facing downwind (so that the wind hits me in the back)?*
- ☐ *Are my fellow astronauts or observers behind me?*

☐ *Hold your rocket plane in position to launch. Do a loud countdown 3...2...1..LAUNCH and give your rocket plane a **LIGHT** shove upward. Let go of the propeller and the rocket plane at the same time.*

☐ *Observe the launch phase. Your airplane should ascend while rotating around its own axis. Once it runs out of power it should transition into the glide phase.*

☐ *Observe the glide phase and adjust your rocket plane if it does not glide as well as you think it could. Use the elevons and the tail pinch to make it glide better if necessary.*

☐ *Fly the different competitions and award points to the winners. Use the Astronaut Point Scoring Sheet to keep a tally of the points awarded.*

Above all, have a lot of FUN!

Best decorated Rocket Plane Pageant

Before you head out to the launch pad or flying field, it is a good idea to have your students line up their rocket planes in a long line on a table or similar. Assign a number to each plane starting with 1, 2...and so on.

Give each student one piece of paper where they should write the number of the rocket plane that they like best without considering their own rocket plane.

They should hand those pieces of paper to the instructor. The instructor adds up how many votes each rocket plane received and announces the winning number. The student that decorated the winning number should receive 10 points. 5 points are awarded for second place and 3 points for third place.

If there is a tie, all the tying students are awarded the same points.

Astronauts Points Scoring Sheet

We recommend you use a clipboard and a pen or pencil to fill in all your student names on the Astronaut Point Scoring Sheet. Under the first competition, award the points received during the best decorated rocket plane pageant.

Use the Astronaut Point Scoring Sheet on the next page throughout the flying portion of your program. You should have it with you at all times during the flying contests. Make a few copies in case you fly additional competitions.

How Many Point Do You Assign?

We have provided a guideline for how many points we recommend that you award in the text on the competition page as well as in the pageant text above. You however can develop your own points scoring system.

ASTRONAUT POINT SCORING SHEET

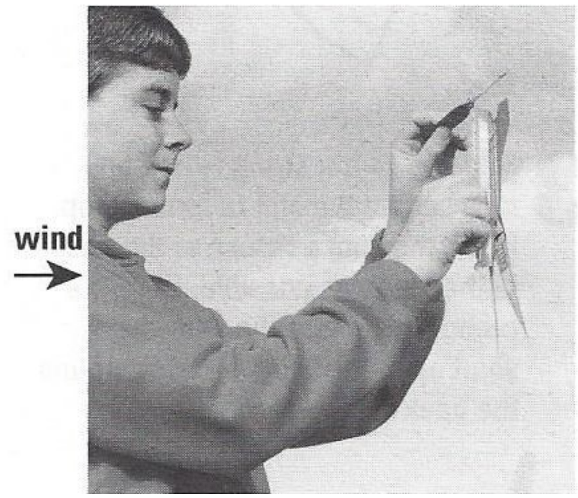
Astronaut Name	Pageant	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Comp. 5	Comp. 6	Comp. 7	Comp. 8	TOTAL

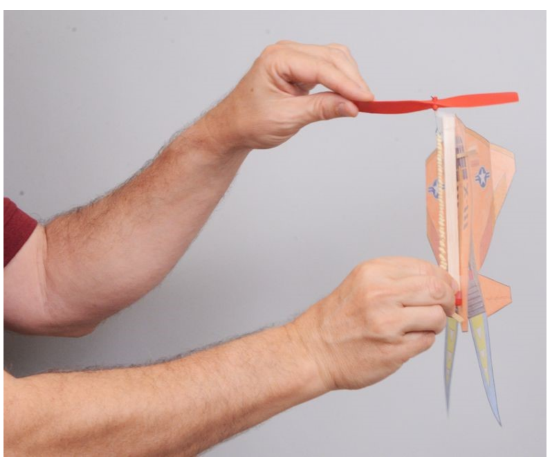
Launching your rocket plane outdoors.

Safety Note: *Always wear eye protection when flying model aircraft. Never launch your aircraft in the proximity of power lines. Never launch your aircraft toward another person or animal. Never launch your Rocket Planez™ indoors.*

Wind Check: *Before you launch your rocket plane, check for wind direction, then position yourself so the wind hits you in the back.*

Wind the propeller at least 120 times. If you hear a clicking noise, you are winding the wrong way. Wind more to gain higher altitudes. You can safely wind about 200 to 220 winds by hand into the motor. Wind slowly to prevent the motor from breaking due to excessive friction heat. When you are satisfied with the winds, hold your rocket plane vertically as shown. One hand holds the end of the motor stick, the other hand secures one propeller blade tip. Position yourself such that the wind hits you in the back! Release with a gentle upward push. Your rocket plane should spiral vertically upward under power and glide back to the ground. Always launch your rocket plane vertically as shown.





The best way to hold a rocket plane ready to launch is shown to the left.

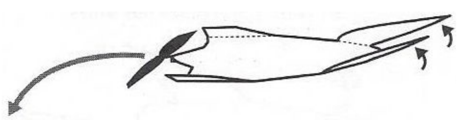
Launch tips: *If your rocket plane does not take off vertically and gain altitude while spinning around it's own axis:*

- *Check whether the wing spar or the tape holding it extends past either end of the wing spar tape markings. If they do, adjust referring to step 1 in the assembly instructions.*
- *Wind your rocket plane more.*
- *Slightly reduce the amount of V-shape between the tails from instructions step 5.*

Glide portion of the flight.

Observe the glide portion of your rocket plane's flight.

Gliding tips:



If your rocket plane flies up, down, up, down (wave pattern) during the glide phase of the flight: *Your rocket plane is stalling out. Bend both trim tabs down a little bit and try again.*

If your rocket plane dives toward the ground during the glide phase: *Increase the V shape between the tails from instruction step 5 and/or bend both trim tabs up a little.*

If your rocket plane glides in a left spiral: *Bend the right trim tab up a little to make it fly straight or make it spiral to the right.*

With the use of a mechanical winder, you can stretch-wind twice the amount of winds into the rubber motor compared to winding by hand. This of course results in higher altitudes reached and much longer flight times.

Introducing teamwork to launch to greater altitudes.

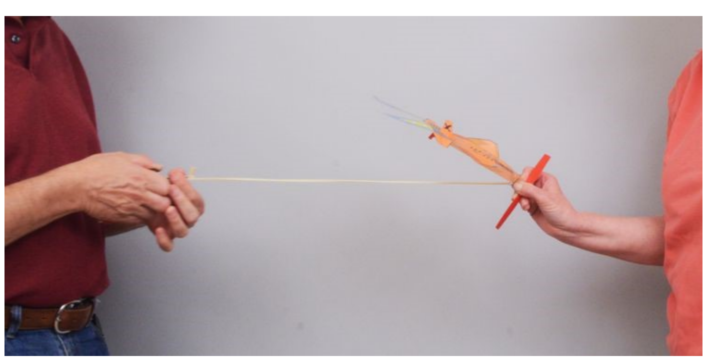
When men flew to the moon, a lot of people were required to work closely together to accomplish the missions. This is called team-work.

Teamwork is also required to launch your rocket planes to greater altitudes for extended flight times. In order to pack more winds into your rubber band motor, you need to wind the rubber motor as it is stretched out. You need a friend to help you wind your plane and we recommend you use a mechanical winder.

One person holds the rocket plane with the tail pointed up as shown below. The other person unhooks the rubber band motor in the back of the rocket plane, hooks it into the mechanical winder and stretches the rubber motor about 3 to four times it's original length. Then you wind slowly until it gets tough to wind. Keep winding slowly while you move towards the rocket plane. When you are close to the rocket plane, pinch the motor close to the winder between two fingers and let the winder dangle free. A few winds will undo, but it will allow you to attach the motor to the motor hook of the rocket plane. Practice makes perfect. Detailed instruc-tions on how to wind and hook the wound motor back to the aircraft are included with the mechanical winders.

With a winder you should be able to crank 400 to 600 winds into the same motor which usually breaks if you try to hand wind it more than 220 times.

Get your mechanical winders today at aeroracers.com



The different flight competitions you can do with your students:

A word of caution:

Tell your students that anytime they fly their rocket planes, they should stay put at the launch spot after they launched their rocket planes. After ALL rocket planes have landed, students should go retrieve their rocket planes in an orderly fashion without running or stepping on other students' rocket planes.

It is a good idea to get all the students to chime in during the count down 3..2..1..LAUNCH!! This way everybody is aware that one or more students are launching their rocket planez.

Two student fly-off.

Line two students up at a time. Position yourself downwind. Make sure the students face you and the wind hits them in the back. They should have wound their rocket planes already. Have all students participate in the countdown. 3...2...1....LAUNCH!!

Both students let go of their rocket planes at the same time. The best flying rocket plane is the last to land and hence is the winner. You can assign points to the winner or gather the winners to one side and the runner-ups to the other. In the end, the winner from the winning side will go against the winner from the runner-up side for overall glory. That way, students that did not win during their first flight, can still come back and win.

Accuracy landing.

Rocket planes will travel somewhat with the wind. Place a hula hoop or similar about 30 feet downwind from the launch spot. Each student launches one at a time and you measure how many feet each plane lands away from the hula hoop. If a plane lands inside the hula hoop or part of it touches the hula hoop, award 100 points. If the rocket plane is 20 feet away, award 80 points (100-20=80). You can run this and other competitions over a period of several days and keep track of how many points each student has earned.

Time aloft.

Use a stop watch to time each student's rocket plane flight from the time it leaves the student's hand until the rocket plane touches the ground or flies out of sight. Each second aloft is awarded one point rounded up to the next second. For example, a flight time of 23.13 seconds will be awarded 24 points.

The mass launch.

The mass launch is the most popular. You should do a few of those every day towards the end. The winner is the last plane to land as it is the best flying aircraft.

For a mass launch, line up the students upwind from you. Ask the students to stand apart by at least 5 feet. If you are working with many students, you can form several rows of students. They all should face you. The wind should hit them in the back. Give the students a 2 minute warning to wind their aircraft. If a student breaks a rubber motor during those 2 minutes, that student should sit out the current mass launch and can participate in the next one.

After two minutes you give the "STOP WINDING" command and have them hold their planes ready to launch. Remind the students that it is very important to stay in place after they have released their rocket plane and they should all watch which plane lands last. 3....2....1..LAUNCH. STAY WHERE YOU ARE!!... After the last plane has landed, you go retrieve the winning plane and award 25 points or more to that astronaut. Of course you will have to do it all over again as everybody will want to launch again.

Longest Distance Flown.

Pick a point that you designate as the launch site. All students should launch from that spot. Students should launch their rocket planes one by one and set their plane to glide as straight as possible since that will give them the longest distance. Since not all rocket planes will land in the same vicinity, it is a good idea for the instructor to walk the distance from the launch point to each landed rocket plane and count the steps. Award 1 point for each step taken. After the competition, the longest distance recorded receives an additional 10 points.

Lesson Plan 5 Rocket Planez™

Basic Aerospace Engineering Experience

Time needed: *Approximately 1 hour*

Materials needed: *AeroRacers Rocket Plane ready to fly*

Flight Log

☐ *Copy the four pages of the flight log and hand one copy to each student. They should fill in their name and date on the front page.*

Aerospace Engineering (as long as you dare)

☐ *Do a pre-flight check:*

- ☐ *Which direction is the wind coming from?*
- ☐ *Am I facing downwind (so that the wind hits me in the back)?*
- ☐ *Are my fellow astronauts or observers behind me?*

☐ *Wind your rocket plane exactly 100 times. Fly it and have a fellow student record the flight time from launch until it touches the ground. Record the result under test flights.*

☐ *Wind your rocket plane exactly 125 times. Fly it, time it and record the result under test flights.*

☐ *Wind your rocket plane exactly 150 times. Fly it, time it and record the result under test flights.*

☐ *Fill the three test flight results in the graph. Draw a best possible straight line through the three points (a line that goes through or gets closest to all three points and keeps going) and it will predict flight time at 200, 250 and so on winds.*

☐ *Wind your rocket plane exactly 200 times. Fly it, time it and compare the flight time result with the number predicted by the graph. Discuss differences in the flight time. That discussion will make you talk like an aerospace engineer.*

Above all, we want you to have a lot of FUN!

Go to www.aeroracers.com for additional rubber motors and mechanical winders to make your rocket planez go higher and higher.

Flight Log

Year:…………………………………………..

Astronaut Name:………………………….

Aircraft type: AeroRacers Rocket Plane

TEST FLIGHTS

Date: __________________ Location: _____________________________ Time: __________________

Temp: _______________ Wind Conditions: ____

POWERED FLIGHT TESTING

FLIGHT #1

Power: _____________ winds Time aloft: ___________________ seconds

Problems: ____

____

Solution: ____

____

Comments: ____

FLIGHT #2

Power: _____________ winds Time aloft: ___________________ seconds

Problems: ____

____

Solution: ____

____

Comments: ____

FLIGHT #3

Power: _____________ winds Time aloft: ___________________ seconds

Problems: ____

____

Solution: ____

____

Comments: ____

TEST FLIGHT:

PREDICTING TIME ALOFT

1. Fill in graph on the next page using your flight data from previous page

2. Draw a best possible straight line connecting all points (a line that goes through or gets closest to all three points and keeps going)

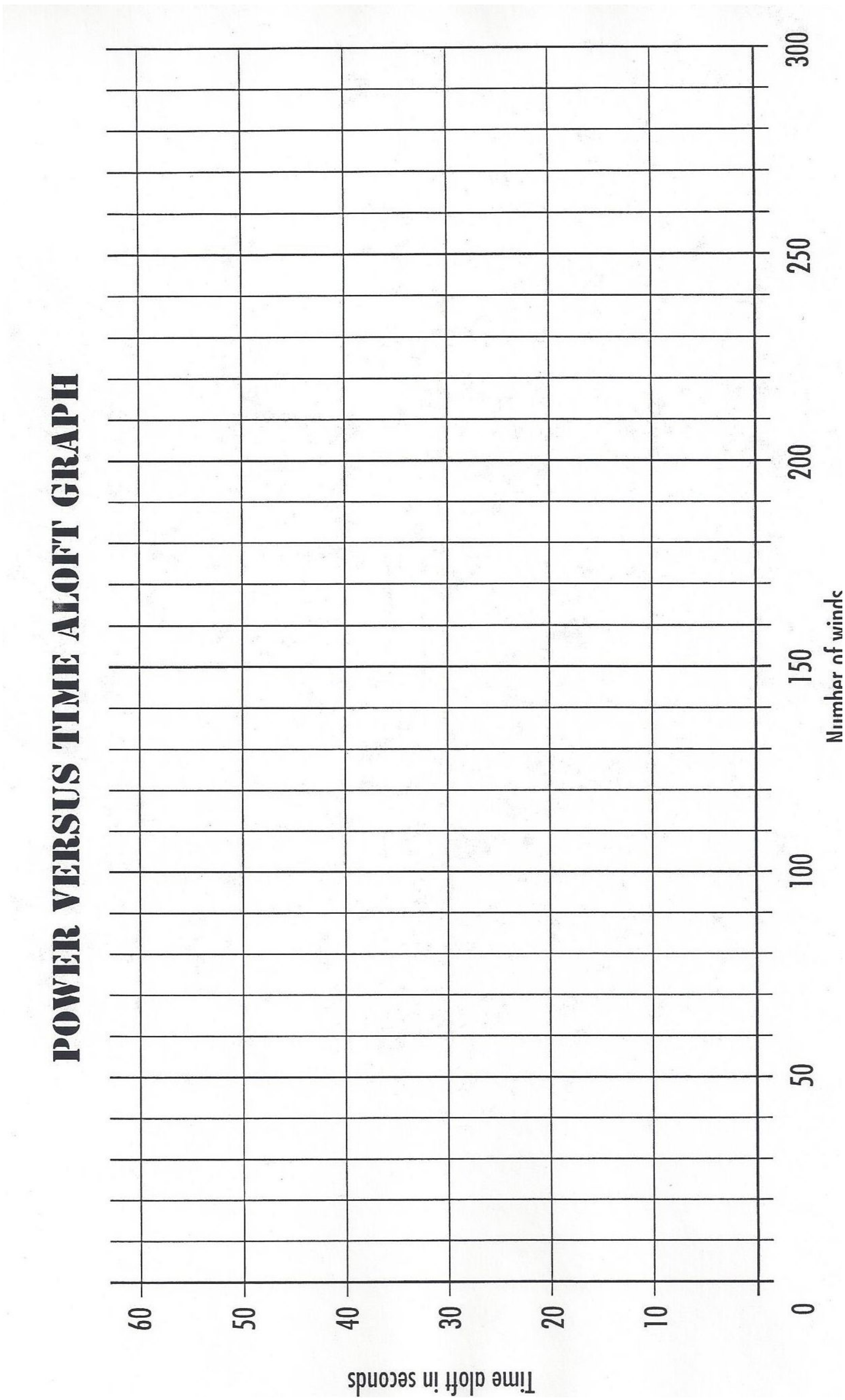
3. Predict your flight time at _____________ winds, as instructed by your teacher

   Predicted flight time: __________ seconds

4. Wind rocket plane and fly again

   Actual flight time: __________ seconds

5. Explain the differences between your predicted and actual flight time
   ____
   ____
   ____
   ____


POWER VERSUS TIME ALOFT GRAPH
Number of winds
0
50
100
150
200
250
300
Time aloft in seconds
10
20
30
40
50
60

