
ESTES
ROTO ROCKET
STEM KIT
ACTIVITY BOOK
ROTO ROCKET

TOP SECRET

At 18:00 hours, our offices received word that an alien colony has taken residence on the Moon. This species travels in ships that look like our helicopters; and this is where you come in, Roto Rocket. To collect as much information about the aliens as possible, we need to blend in with them and observe their daily habits. Your specialized rocket will launch from Earth to the Moon, and once it is descending over the moon the recovery system blades will pop out and make it look just like a helicopter.

Your rocket is equipped with two different types of blades. You need to test each of them and decide which set you will use for each part of your mission.

Part 1 - The Surface of the Moon

For this mission, you must:

- **Descend quickly to not draw attention to your spacecraft.**
- **Take audio surveillance during the descent.**
- **Land close to your launch pad for a speedy return to Earth.**

Part 2 - The Craters of the Moon

For this mission, no one will be able to detect your rocket in the dark craters, so you must:

- **Descend at a slower rate.**
- **Collect data using Night Vision technology to see in the dark.**
- **Land close to your launch pad for a speedy return to Earth.**

Good Luck, Pilot!

MISSION PREP

Before you begin your mission, you need to understand how helicopters work.

Lift Levels

Air must move across the surface of a wing to produce lift.

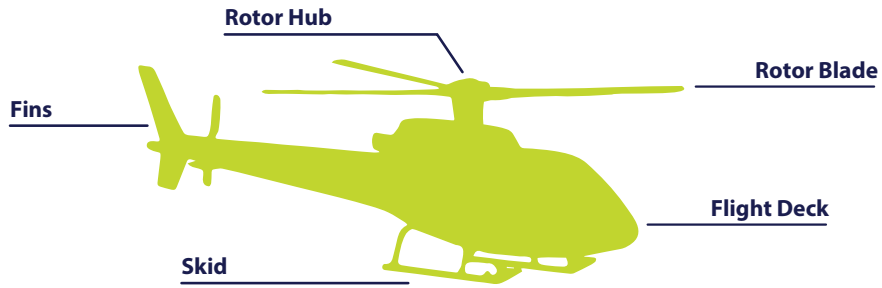
Birds flap their wings to move air over and around the wing surface. **Airplane wings** are attached to the body of the plane so the whole plane must move forward through the air for lift to be created. **Helicopters** rotate their blades through the air to produce lift.

Blade Business

The helicopter is a type of aircraft in which **lift** *(force that holds the helicopter in the air)* and **thrust** *(the power used to fly)* are supplied by horizontally spinning rotors or **blades**. This allows the helicopter to take off and land vertically, hover, and fly forward, backward and side to side.

These special features make helicopters perfect machines to use in busy or tight areas that are not reachable by planes or aircraft that need a runway.

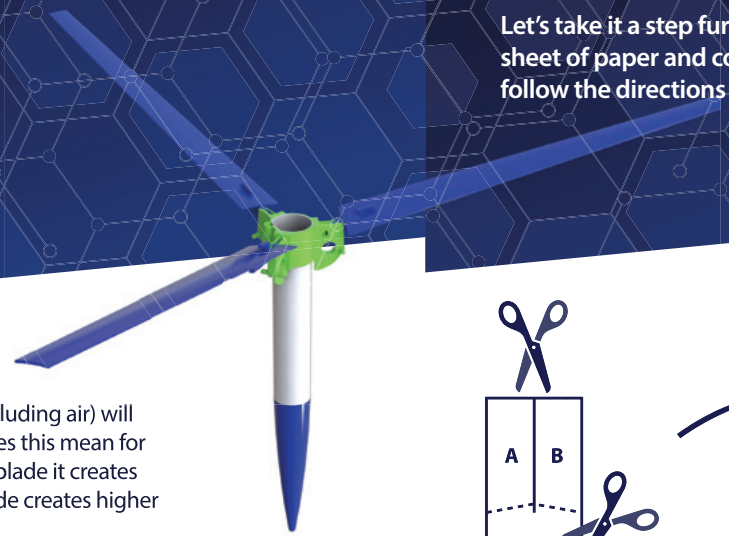
Lift is generated when the angled blades of the helicopter deflect air particles around the blade. This causes low air pressure above the blades, and high pressure below the blades. The high pressure then lifts the helicopter up into the air.



MISSION PREP

Rocket Connection

In your Roto Rocket's descent, the spinning blades will create **lift** which pushes up on the rocket and opposes the force of gravity pulling down on the rocket. This allows the rocket to land softly and safely.



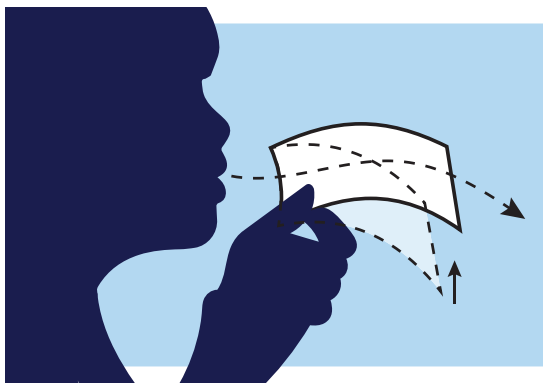
Fly Zone

Bernoulli's Principle tells us that faster moving fluids (including air) will have lower pressure than slower moving ones. What does this mean for our helicopter? As fast air moves over the top of a rotor blade it creates an area of lower pressure. Then slower air below the blade creates higher pressure and pushes the helicopter up.

Let's test this out with a simple experiment. All you need is a sheet of paper.

Hold the sheet of paper horizontally on one of the short sides so that the other side just hangs freely. Now, take a big breath and blow over the curved top of the paper. What happens to the paper?

Try adjusting how you blow on the paper. Blow slower and see what happens to the paper. Now blow faster.



What did you notice? Make this statement true by circling the correct terms.

When you blow the air...

FASTER **SLOWER**

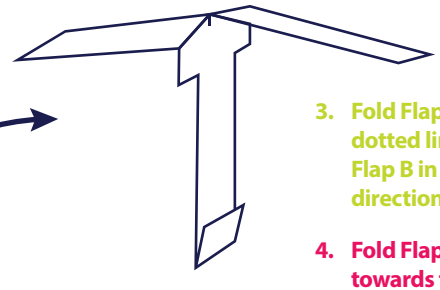
the paper lifts...

LESS **MORE**

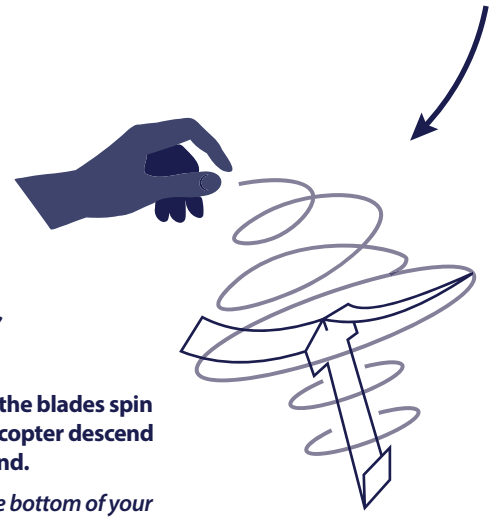
PROTOTYPE PRACTICE

Let's take it a step further and create your own helicopter prototype! Get another sheet of paper and copy this template onto it. Carefully cut out the template and follow the directions below.

1. **Draw this template on a paper. Use a ruler for straight lines.**
2. **Cut along the solid lines of the template.**



3. **Fold Flap A along the dotted line then fold Flap B in the opposite direction.**
4. **Fold Flaps X and Y in towards the center, and then fold Z up along the dotted line.**



Let's Fly!

Now you are ready to see how the blades spin and create lift to make the helicopter descend slowly to the ground.

***Optional:** Attach a ribbon to the bottom of your helicopter to help you track its movement.*

ROTO RESEARCH

Try the following experiments with your helicopter prototype:

1. Once your helicopter is made, raise it about shoulder level and drop it. How does the helicopter move? (Hint: adding a ribbon can help you track the movement.)
2. Now, grab the paper that you used earlier to test Bernoulli's Principle. Drop it at the same time as the helicopter. Which falls faster?
3. This time crumple the paper into a ball and drop it at the same time and height as your helicopter. Now which falls faster?
4. Fold the edges of the blades. Does that change the way the helicopter moves?
5. Drop your helicopter from different heights. Count the rotations (how many spirals the ribbon makes). How does changing the height change the amount of rotations?
6. Try a spot landing. Can you get the helicopter to land in the same spot on each drop?

Now that you have learned about the unique features of helicopters and made your own, can you think of a special mission that would require the use of a helicopter? Draw or write about it in the box below.

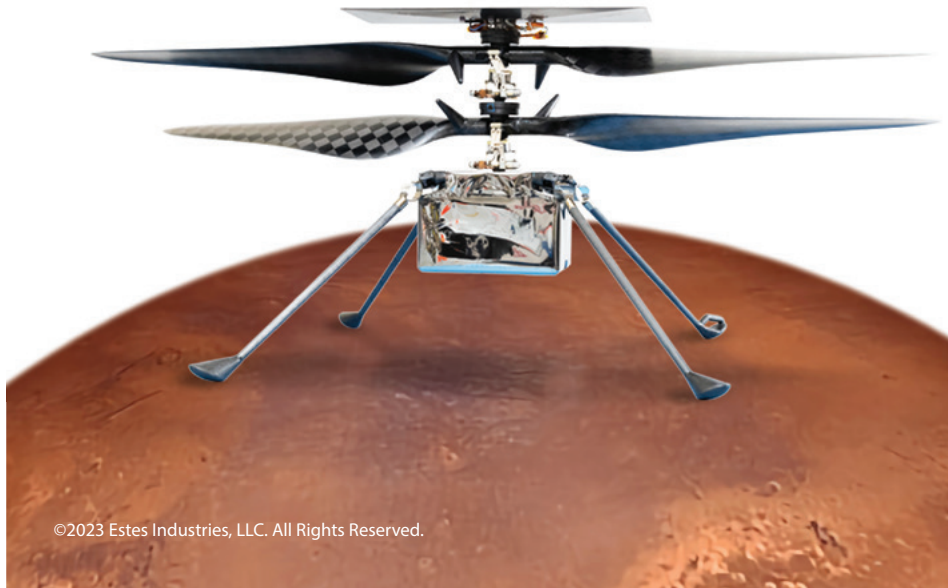
MARS HELICOPTER INGENUITY

Real World Connection

Learn more about NASA's Mars Helicopter Ingenuity.

NASA is using a helicopter while they are working on Mars. They went through many different experiments just like you did to get the helicopter right for the harsh conditions of Mars.

The Martian atmosphere is very different than Earth's and much more lift is needed on Mars to allow Ingenuity to fly. To compensate for that, engineers had to give the helicopter two sets of huge blades and make them go 10 times as fast as those on Earth!

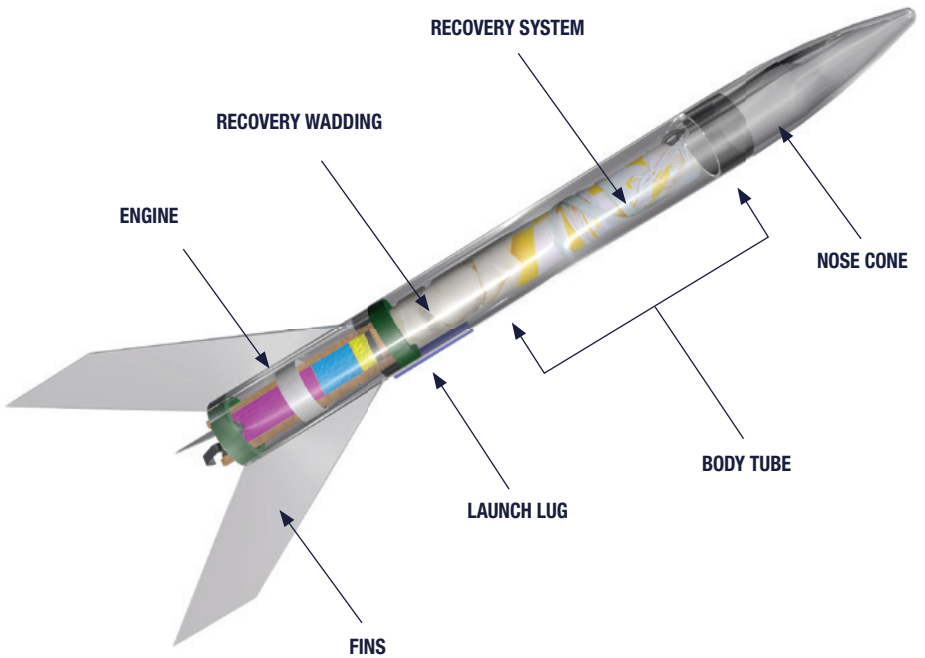


PREPARE FOR LAUNCH

Now that you know more about helicopters and lift, let's get ready for this Roto Rocket mission.

To prepare your rocket, follow these steps:

1. **Unload** all the pieces of your rocket and follow the included instructions to build the rocket.
2. **Decide** which experiments from the following pages you are going to perform.
3. **Prep** your rocket for launch. Add recovery wadding and insert an engine.
4. **Attach** the set of blades that you wish to test.
5. **Look** over the safety guidelines and have an adult assist you with the launch.



SAFETY FIRST!

Review each of these regulations from the National Association of Rocketry before you launch and check off each box to show that you understand it.

www.nar.org/safety-information

Materials

- ☐ Only use materials provided in the rocket kit.
- ☐ Do not tamper with rocket engines in any way.

Launch Site

- ☐ Launch in an open outdoor area (A engines = 100 sq ft; B = 200 sq ft; C = 400 sq ft).
- ☐ Launch only in safe weather conditions (winds less than 20 mph).
- ☐ Be sure there is no dry grass near the launch pad.
- ☐ Do not launch at targets, into clouds, or near airplanes.

Launch

- ☐ Countdown before launch.
- ☐ Be sure everyone stands at least 15 feet away.
- ☐ Launch rod must be within 30 degrees of vertical.
- ☐ In case of misfire, wait 60 seconds before approaching the rocket.

Recovery

- ☐ Do not attempt to recover rocket from tall trees, powerlines, or other dangerous places.

BLADE TRIALS

The purpose of checking the distance from the launch pad to the rocket (once it lands) is to see how close the rocket can get to the launch pad. This is called spot landing. For your mission the rocket must launch a second time from where all the equipment is to return to Earth. The closer it lands to the launch pad, the easier that task will be.

Time your descent and Check your landing.

Once your rocket is built, add the first set of blades to test. You will need a stopwatch for this trial.

Launch your rocket with an adult.

1. Start the stopwatch once the blades pop open.
2. Stop the stopwatch once the rocket lands.
3. Once your rocket lands, walk to your rocket, pick it up and count your steps back to the launch pad.
4. Record your data here.
5. Change the blades to the second set and test again!

Blade Trial	Descent Time (seconds)	Distance to Launch Pad (Steps)
#1		
#2		

Results Requested

Pilot, it's time to make some decisions. Using the data you collected from your launches, fill in the chart below. Which blades will be most effective for your missions? Did you get close to a spot landing?

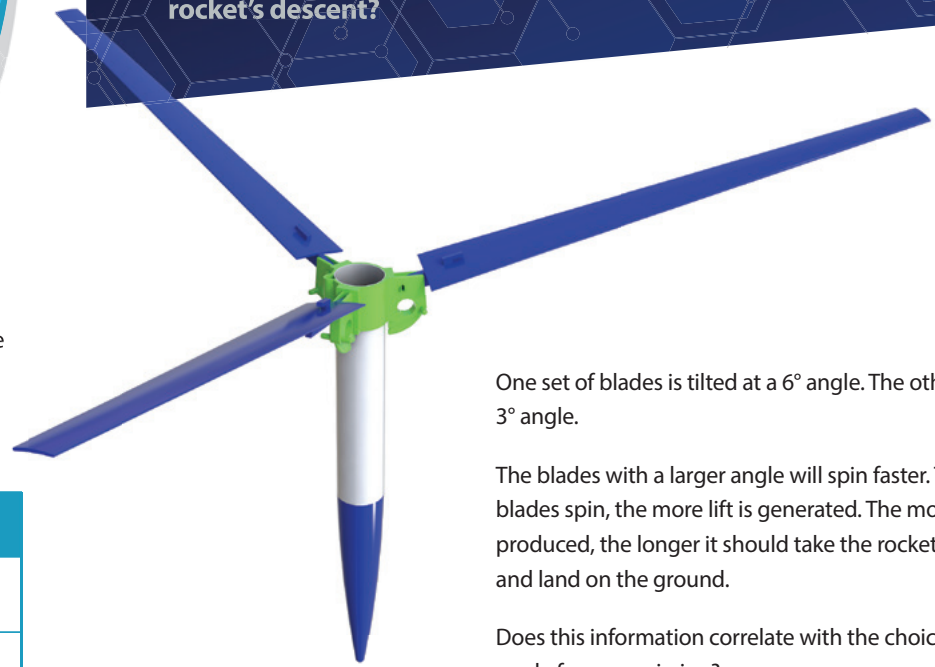
Mission	Blade Choice	Spot Landing
Part 1: The Surface of the Moon		**YES** or **NO**
Part 2: The Craters of the Moon		**YES** or **NO**

THINK ABOUT IT

What did you notice about the blades?

Were there any differences in how they looked?

Were there differences in how they affected the rocket's descent?



One set of blades is tilted at a 6° angle. The other set is at a 3° angle.

The blades with a larger angle will spin faster. The faster the blades spin, the more lift is generated. The more lift that is produced, the longer it should take the rocket to descend and land on the ground.

Does this information correlate with the choices that you made for your mission?

MISSION UPDATE

Based on the data you collected on your mission, we were able to determine that this race of aliens is peaceful. We are setting up communication with them to learn more about each other. We are hopeful this will help us develop a partnership that will benefit us all. Thank you for your hard work and your assistance in moving the human race into the future!

What does NASA know about life in the universe?
Check out their Astrobiology program to learn more!
https://astrobiology.nasa.gov/

Want to launch your rocket again?
Order more engines and keep the fun flying!
www.estesrockets.com