National 4-H Curriculum
BU-06844

Aerospace Adventures

Reaching New Heights

Stage 3

Aerospace Activity Guide

Name _____

County _____

REVIEWED & RECOMMENDED
National 4-H Curriculum

Note to the Project Helper

Congratulations, you have an exciting and challenging role as the helper of a young person interested in exploring the activities in Reaching New Heights. Not only will you be providing encouragement and recognition, you will also be the key person with whom the young person shares each of the experiences outlined in each of the Aerospace Adventures activity guides.

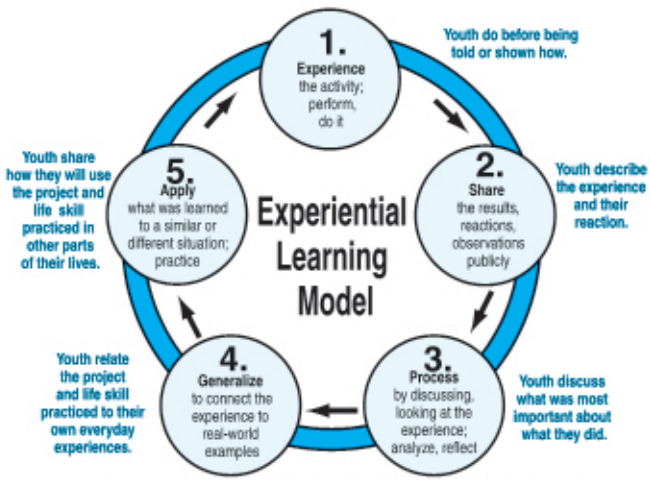
By encouraging young people to set goals and work to complete them, there will be many opportunities to help them develop important life skills they will use each day. These skills include creative thinking, decision making, problem solving, accepting responsibility, managing time and participating as a member of a team. How you are involved will often determine how successful the youth is in developing these critical skills.

The *Aerospace Adventures* Series

A total of five pieces are included in this series. The first four activity guides, *Pre-Flight, Lift-Off, Reaching New Heights* and *Pilot in Command* have been designed to be developmentally appropriate for grades 1-2, 3-5, 6-8 and 9-12 respectively but my be used by youth in any grade based on their project skills and expertise. The fifth piece Flight Crew has been designed to provide group activities that can be organized very quickly and conducted with a group of usually three to fifteen youth.

The Experiential Learning Model

The experiential learning model is used throughout this series to maximize the opportunities for both youth development and aerospace related outcomes. A complete description of the model is shown in the Flight Crew Helper's Guide.



Pfeiffer, J.W., & Jones, J.E., "Reference Guide to Handbooks and Annuals" © 1983 John Wiley & Sons, Inc. Reprinted with permission of John Wiley & Sons, Inc.

Acknowledgments

2003 Aerospace Revision Design Team
Judy Rice, Coordinator and Writer, AL; Tony Cook, AL; Walter Barker, KS; Wade Crouch, MT; Tony Foster, KS; Ann Grimm, CO; David Herzig, MN; Robert Horton, OH; Tom Zurcher, Liaison

1997 Curriculum Design Team
Judy Rice, Coordinator, WI; Tony Cook, 4-H Missions in Space; Gordon Hoff, Office of Aeronautics; Alton Greenfield, Department of Education; Stan Meinen, MN; Sandy Stedman, Jeppesen Sanderson; Ina McLain and Carol Parmenter, Liaisons; and Tom Zurcher, Educational Coordinator. Youth members Laura Binkley, Erin Duffy, Matt Franklin, Heather Harding, Ryan Kivisko, Ted Knight, Kyra Mangold, Jason Mell Benjamin Rice, Taylor Tappan, Kathryn Thatcher, Bart Werness, Drew Yeager, Mike Zebill.

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Launch Pad

Stage 3 Reaching New Heights







For more on Aerospace, look for these other guides in this set.

Stage 1 Pre-Flight

5...4...3...2...1...
Wonderful Wings
What Do You Do?
Space Buggy

Stage 2 Lift-Off

Rockets Away!
Gnome of Your Own
I Want to Be…
Airfoil Magic
From Here to There!
Follow That Shadow
Can I Fly Today?
Which Way Is Up?
Angle of Attack!
Up, Up and Away
Round and Round
Charlie Oscar Delta Echo
From Nose to Tail

Stage 3 Reaching New Heights

Rippin' Rockets
Fly'n Show
Let's Go Launching
Attitudes, Altitudes and Airspeed
Rudder Away
Follow That Shadow
Flying My Way
Star Gazing
Powerful Payload
Flying Fighters
Mustangs to Zeros
Copters and Robbers
Just Blowing Through

Stage 4 Pilot in Command

Versatile Viking
Altitude Advisors
Future Pilot
Ace Instructor
Cross Country
Knowledgeable Navigators
Astronaut Aerobics
Brouhaha Box Kite
Care in the Air
Elevator Magic
Circle of Power
My Personal Qualities

Flight Crew Helper's Guide

Aerospace Quiz Bowl
Aircraft Fire Rescue
Afterburner
Top Gun
Far Out!
Community Airport Field Day
Flight 777
Aerospace Experts
Traffic Cop in the Sky
Space Station Skillathon
Aerospace Alphabets Games
Touring An Airport
Full of Hot Air

Getting Started

Ready to explore more aerospace activities? Whether you have just started the aerospace project or already know all about rockets, hot air balloons, airplanes and kites you'll enjoy the activities in *Reaching New Heights*. Get ready to file your flight plan, select your aerospace helper and complete the Reaching New Heights Achievement Program. Enjoy the flight!

Stage 3 - Reaching New Heights

Guidelines

1. File your Flight Plan and record your progress.
2. Complete at least seven activities in your Reaching New Heights Achievement Program each year and at least 20 activities in three years.
3. Discuss each experience with your aerospace helper.
4. Have fun!

Developing Your Skills

This is your guide to exploring aerospace and developing important skills that will help you throughout your life. As you do the activities you'll be practicing the types of skills employers consider essential to success. These include communication skills, creative thinking, decision making, problem solving, accepting responsibility, managing time, money and human resources, working with diversity, teaching others and participating as a member of a team. Do you know how skilled you are at each of these? The activities will help you build your skill level in each of these important areas.

Your Project Helper

Your aerospace project helper is an important part of your overall experience. The choice of a helper is yours. This person may be your project leader or advisor, troop leader, teacher, family member, neighbor, friend or anyone who has the interest to work with you to complete the Reaching New Heights Achievement Program. Involve your helper as you set your goals, discuss the questions found in the Debriefing section of each activity and sometimes work together on an activity.

Write the name and phone number of your aerospace helper here:

Helper's name: _____

Phone number: _____

Flight Plan

Stage 3 Reaching New Heights

Destination Log

Name _____

My most important aerospace project goals:

_____
Year

_____

_____
Year

_____

_____
Year

_____

Learning Experiences

Do a minimum of three each year.
Record the date you complete each one.

Year	Year	Year	Activity
			Build and fly a model airplane
			Shadow an airline employee for one day
			Give an aerospace presentation
			Help arrange an airport tour
			Exhibit at a fair
			Fly in a real airplane
			Help conduct an aerospace skillathon
			Belong to an aerospace club or group
			Recruit someone to join your aerospace group

Aerospace Activity Log

Date and list exciting things you do and learn in the aerospace project.

Achievement Program

Stage 3 Reaching New Heights

To Complete:

1. Do a minimum of seven required and/or optional activities each year
2. Complete at least 20 total activities to pass the Reaching New Heights Achievement Program
3. Have your aerospace helper date and initial each activity when completed

Required Activities

Complete at least 10 of the 12 activities

Rippin' Rockets
Date_____Initial_____

Fly 'n Show
Date_____Initial_____

Let's Go Launching
Date_____Initial_____

Attitudes, Altitudes and Airspeeds
Date_____Initial_____

Rudder Away
Date_____Initial_____

Flying My Way
Date_____Initial_____

Star Gazing
Date_____Initial_____

Powerful Payload
Date_____Initial_____

Flying Fighters
Date_____Initial_____

Mustangs to Zeros
Date_____Initial_____

Copters & Robbers
Date_____Initial_____

Just Blowing Through
Date_____Initial_____

Solo Flight Optional Activities

Select and do any of the Solo Flight activities in this guide.

Page	#	Date Completed	Helper's Initials

Write your own activity

1.

Date_____Initial_____

2.

Date_____Initial_____

3.

Date_____Initial_____

Reaching New Heights

Completion Certificate

I certify that

_____

has completed all requirements of the
Reaching New Heights Achievement Program
in the Aerospace Adventures Series.

Helper's signature_____

Date _____

A picture of me and
my project.

Rippin' Rockets

Rocket science this may be! Still, you will be doing a series of experiments and only you can find the solution. In this activity you will experiment with the design of a balloon rocket until it will fly in the direction of your choice.

Activity: Build a drinking straw and balloon rocket

Aerospace Skill: Building a straw and balloon rocket

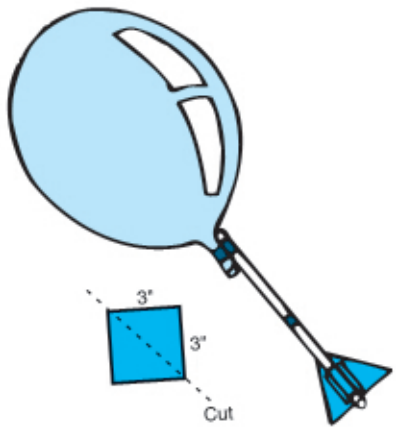
Science Skill: Building models, experimenting

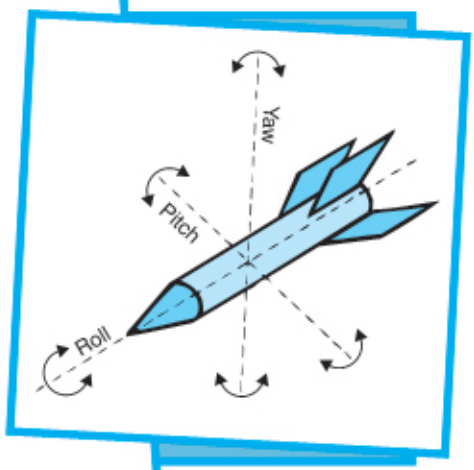
Materials: 2 flexible drinking straws, cellophane tape, 3" square of paper, balloon, scissors

Blast Off

Make your balloon rocket using the directions at right. Then work together with a friend to do the experiments below. Record and compare the results.

1. Inflate your balloon. Let it go.
2. Cut the rim off your balloon. Cut an inch piece of one of the drinking straws (should be just below the bend). Insert open end of balloon and tape securely to the unbendable, 1" cut piece of straw. Inflate your balloon with the straw piece. Let it go. Note changes.
3. Take the remaining piece of plastic drinking straw and insert its end into another whole plastic drinking straw. (Be sure to have the bendable end of the whole drinking straw at one end and not in the middle of each straw!)
4. Tape the 1" piece of straw with balloon to the bendable end of long attached straws. Inflate your balloon with straws now attached. Let it go. Note changes.
5. Take a piece of paper 3 inches square and cut in half diagonally. Tape the pieces of paper to the end of the straw without the balloon to resemble "fins" (see diagram). Inflate your balloon rocket. Let it go. Could you maintain directional control? Why?
6. Experiment with your balloon rocket until you can control its direction of flight.





Take a piece of paper 3 inches square and cut it in half diagonally. Tape these pieces of paper to the bottom of the straw as shown.

Test	What happened? Why?	Friend's results? Why?
1		
2		
3		
4		
5		

Debriefing

Ground to Ground (Share)

- What experiments did you do?
- How did you and your friend's results compare?

Climb Out (Process)

- What did you learn about directional control?

Level Off (Generalize)

- What did you learn about conducting a series of experiments?

Cross Country (Apply)

- In what other areas of your life do you experiment and make adjustments to solve problems?

Experiments can be fun to do.

Aerospace Facts — Making Rockets Stable

Making a rocket stable requires some form of control system. The simplest of all controls is a stick. Chinese fire-arrows were simple rockets mounted on the ends of sticks.

Rockets are stabilized by the effects of air movement on their fins, which function as controls. Even a long rocket will ***roll***, ***pitch***, and ***yaw*** if the force of air hitting its surface is not controlled. For a rocket to fly properly, pitch and yaw axes are the most important to control because any movement in either of these two directions causes the rocket to go off course. The roll axis does not affect the ***flight path***. A rolling motion helps stabilize the rocket, but it also uses some of the energy needed for forward motion.

Solo Flight

1. Make a Monarch™ or an Alpha™ rocket.

2. Design and build your own rocket using materials other than straws and balloons.

3. Conduct a rocket design and launch contest with your friends. Categories might include designs, distance, height, accuracy, etc.

Fly 'n Show

Do you like to go to the fair? Meet other people? Win a ribbon? Learn more about rockets? Have fun? Then this is the activity for you! You will not only learn more about rockets but you'll also learn about communicating, working with others, managing your time and using information.

Activity: Prepare and give a speech about a model rocket exhibit

Aerospace Skill: Exhibiting a model rocket

Life Skill: Communicating

Materials: Pen or pencil

Blast Off

Exhibiting a rocket involves more than just showing your rocket to the public.

Understanding, responding to questions and making decisions are as much a part of the judging process as workmanship. Prepare and give a talk about a model rocket you have made. Use the space on the right to outline your talk. Ask a family member or friend to be a "judge" and rate your talk in the score card. Change roles and you be the judge. When you are finished, discuss ways to improve each other's talks.

Check off the things you might consider including in your talk:

- ☐ kind/make of your rocket
- ☐ what was most difficult/ easiest in making it
- ☐ what helped you the most
- ☐ how to test for stability
- ☐ safety rules
- ☐ engine sizes
- ☐ construction (time, process)
- ☐ recovery systems
- ☐ what you would do differently next time
- ☐ work skills you practiced

Notes

Talking with the judge

Introduction
(Catches attention and tells what you will say)

Body
(What you say)

Conclusion
(Summarize what was said)

Rocket Exhibit
Score Card

Date _____

Judge's Name _____

I. **General Appearance** (10 points)

Neat, attractive in color and decoration

II. **Workmanship** (50 points)

Body tube: smooth, free of dents/nicks

Fins: aligned, rounded edges

Engine mount/launch lug: in place, snug

Recovery system: operative, shock cord in place, nose cone ejects freely

Finish: smooth, decals straight

Stability: knowledge of how to test

III. **Talk** (40 points)

Knowledgeable, confident, responds to questions, makes decisions, dresses neatly, on time, prepared

Total

Debriefing

Ground to Ground (Share)

- What was most fun about this activity?
- How did you prepare your talk?

Climb Out (Process)

- What is the most important part when exhibiting your rocket?
- What will you do differently to your rocket next time?

Level Off (Generalize)

- What did you learn about talking with others?

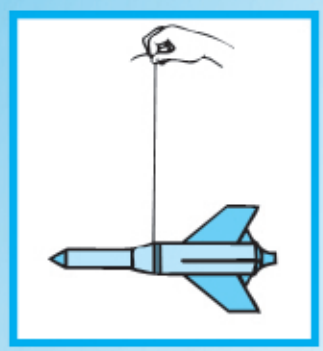
Cross Country (Apply)

- How can preparing and practicing for an exhibit help you prepare for a job interview?

Aerospace Facts

Rocket Stability Test

One way to test for stability in a rocket is to attach a string snugly to the center of the rocket and swing it in a circle over your head. The rocket points forward if it is stable.



Solo Flight

1. Give a speech to a class, 4-H club or science fair about an aerospace topic.

2. Conduct a rocket show with your friends, class or an elementary class.

Let's Go Launching!

Activity: Organize a Gnome™ model rocket launch

Aerospace Skill: Launching a Gnome™ rocket

Life Skill: Communicating

Materials: Launchable Gnome™ rocket, NAR rules

Once you have built an Estes Gnome™ rocket, you are ready for the ultimate — the Launch! A successful launch depends a lot on the proper preparation. Rockets can reach speeds of 400 mph. Following National Association of Rocketry (NAR) rules is essential. Ask an older youth or an adult who is familiar with rockets, launches and the NAR rules to help. You and your friends will work together as you prepare to launch your Gnome™ model rocket. Finally, launch your rocket.

Blast Off

Discuss with your helper what needs to be done to ready the rocket for a flight by using the questions below. Be sure to check the Gnome™ instructions for launch precautions. When you have discussed and checked off all the questions, list five launch sequence steps you will use. Then prepare and give a demonstration to at least three other people on how to launch a rocket.

- ☐ **1.** What are the steps necessary to prepare a rocket for launch?
- ☐ **2.** What is the purpose of the wadding? How much is needed and what materials should you use?
- ☐ **3.** How do you fold and pack streamers?
- ☐ **4.** What happens if the nose cone is too tight?
- ☐ **5.** What can you use to make streamers work more easily?
- ☐ **6.** What engine size should you use for your rocket? (See manufacturer's suggestions.)
- ☐ **7.** What can you do to be sure the igniter is firmly held in place?
- ☐ **8.** Describe a safe launching system.
- ☐ **9.** Why use a safety interlock key? How far away should people be from the launch site?
- ☐ **10.** How do you determine the angle of the launch rod? What is the purpose of the end-launch cap? Why do you use a jet deflector?

Model Rocket Safety Code

1. **Materials** - My model rocket will be made of light-weight materials such as paper, wood, rubber, and plastic suitable for the power used and the performance of my model rocket. I will not use any metal for the nose cone, body, or fins of a model rocket.
2. **Motors/Engines** - I will use only commercially-made NAR certified model rocket engines in the manner recommended by the manufacturer. I will not alter the model rocket engine, its parts, or its ingredients in any way.
3. **Recovery** - I will always use a recovery system in my model rocket that will return it safely to the ground so it may be flown again. I will use only flame-resistant recovery wadding if required.
4. **Weight and Power Limits** - My model rocket will weigh no more than 1500 grams (53 oz.) at lift-off, and its rocket engines will produce no more than 320 Newton-seconds (4.45 Newtons equal 1.0 pound) of total impulse. My model rocket will weigh no more than the engine manufacturer's recommended maximum lift-off weight for the engines used, or I will use engines recommended by the manufacturer for my model rocket.
5. **Stability** - I will check the stability of my model rocket before its first flight, except when launching a model rocket of already proven stability.
6. **Payloads** - Except for insects, my model rocket will never carry live animals or a payload that is intended to be flammable, explosive, or harmful.
7. **Launch Site** - I will launch my model rocket outdoors in a cleared area, free of tall trees, power lines, buildings, and dry brush and grass. My launch site will be at least as large as that recommended in the following table.

LAUNCH SITE DIMENSIONS

Installed Total Impulse (Newtons-seconds)	Equivalent Engine Type	Minimum Site Dimension (feet)	(meters)
0.00–1.25	1/4A & 1/2A	50	15
1.26–2.50	A	100	30
2.51–5.00	B	200	60
5.01–10.00	C	400	120
10.01–20.00	D	500	150
20.01–40.00	E	1000	300
40.01–80.00	F	1000	300
80.01–160.00	G	1000	300
160.01–320.00	2Gs	1500	450

Launch Sequence Steps

1.
2.
3.
4.
5.

Debriefing

Ground to Ground (Share)

- How would you feel if you flew in a rocket-propelled vehicle?
- What did you enjoy most about launching your rocket? Least?

Climb Out (Process)

- Why do you think the NAR rules are important?
- Whose responsibility is it to know and observe safety rules?
- What are the rocket flight path phases?

Level Off (Generalize)

- When else do you need to follow rules for safety reasons?

Cross Country (Apply)

- How are safety rules and policies in general developed and by whom?

Model Rocket Safety Code

(Continued)

8. **Launcher** – I will launch my model rocket from a stable launch pad that provides rigid guidance until the model rocket has reached a speed adequate to ensure a safe flight path. To prevent accidental eye injury, I will always place the launcher so that the end of the rod is above eye level or I will cap the end of the launch rod when approaching it. I will cap or disassemble my launch rod when not in use and I will never store it in an upright position. My launcher will have a jet deflector device to prevent the engine exhaust from hitting the ground directly. I will always clear the area around my launch device of brown grass, dry weeds, and other easy-to-burn materials.
9. **Ignition System** – The system I use to launch my model rocket will be remotely controlled and electrically operated. It will contain a launching switch that will return to "off" when released. The system will contain a removable safety interlock in series with the launch switch. All persons will remain at least 15 feet (5 meters) from the model rocket when I am igniting model rocket engines totalling 30 Newton-seconds or less of total impulse and at least 30 feet (9 meters) from the model rocket when I am igniting model rocket engines totalling more then 30 Newton-seconds of total impulse. I will use only electrical igniters recommended by the engine manufacturer that will ignite model rocket engine(s) within one second of actuation of the launching switch.
10. **Launch Safety** – I will ensure that people in the launch area are aware of the pending model rocket launch and can see the model rocket's liftoff before I begin my audible five-second countdown. I will not launch a model rocket using it as a weapon. If my model rocket suffers a misfire, I will not allow anyone to approach it or the launcher until I have made certain that the safety interlock has been removed or that the battery has been disconnected from the ignition system. I will wait one minute after a misfire before allowing anyone to approach the launcher.
11. **Flying Conditions** – I will launch my model rocket only when the wind is less than 20 miles (30 kilometers) an hour. I will not launch my model rocket so it flies into clouds, near aircraft in flight, or in a manner that is hazardous to people or property.
12. **Pre-Launch Test** – When conducting research activities with unproven model rocket designs or methods I will, when possible, determine the reliability of my model rocket by pre-launch tests. I will conduct the launching of an unproven design in complete isolation from persons not participating in the actual launching.
13. **Launch Angle** – My launch device will be pointed within 30 degrees of vertical. I will never use model rocket engines to propel any device horizontally.
14. **Recovery Hazards** – If a model rocket becomes entangled in a power line or other dangerous place, I will not attempt to retrieve it.

This is the official Model Rocketry Safety Code of the National Association of Rocketry and the Model Rocket Manufacturers Association.

1. Organize a launch for a school class, senior citizen group or community organization.

2. Give a demonstration on rocket safety and how to launch a rocket to a school class or community organization.