

An Achievement Program For Cadets Interested In The Science,
Technology, Construction and Flight of Model Rockets

CIVIL AIR PATROL
**MODEL
ROCKETRY**





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technology and flight of model rockets*

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Published by the
**Leadership Development and Membership Services Directorate,
National Headquarters, Civil Air Patrol, Maxwell AFB, Alabama 36112**

**Cover Images Courtesy of Lockheed Martin and Dennis Ven der Vieren.
Cover Design by Seth Stewart.**

Acknowledgements

The author and project director sincerely thanks those who have helped make this book possible. A special note of thanks goes to Ann Grimm, Director of Education for Estes-Cox Corporation. She made it possible for the Civil Air Patrol to use the company artwork and expertise. Ann is a former teacher who now develops programs that help bring the fascination of model rocketry to classrooms worldwide. For her outstanding contributions in this field, the Civil Air Patrol inducted her into the coveted Crown Circle, one of the highest awards in aerospace education.

A special thanks goes to Dennis Van der Vieren for his outstanding photography and assistance in the beta test with the Dakota Ridge Cadet Squadron. A note of appreciation is given to Captain Courtney Walsh, Commander of the Valkyrie Squadron. Captain Walsh was one of the first to offer help in the production and beta testing of this text. Cadets from both Dakota Ridge and Valkyrie Squadrons are featured in this production and their help is very much appreciated.

The author extends thanks to the team who helped in the review and refinement of the final format. This group included Second Lieutenant Tom Wilson, North Valley Composite Squadron; Major Susan Wilson, North Valley Composite Squadron; Major Bob Johnson, Wing Director of Aerospace Education; Captain Russ Grell, AEO of the Mustang Cadet Squadron; Senior Member Ryan Kubicek, AEO of the Arvada Cadet Squadron; First Lieutenant David O'Rourke, AEO of the Boulder Composite Squadron; Second Lieutenant Dean Anderson, AEO of the Evergreen Composite Squadron; Captain Alan Hergert, Commander Dakota Ridge Cadet Squadron; and Captain Courtney Walsh, Commander of Valkyrie Cadet Squadron. All of these senior staff members are based in the Denver area, Colorado Wing.

The author acknowledges the special art talents of Seth Stewart and Peggy Greenlee. Their work adds the final touch of professionalism and refinement to the text.

In any production, there is always a team that works directly with the author and "makes it all happen." The author expresses special appreciation to the dedication, support, encouragement and hard work given by Judy Rice, Deputy Director of Aerospace Education, Jeff Montgomery, Chief of Internal Aerospace Programs and Judy Stone, Instructional Systems Specialist. These are truly the "missionaries" of aerospace education and the author considers it an honor to work with them on any project.

This text became a reality because of the outstanding vision and leadership of James L. Mallett, Director of Leadership Development and Membership Services.

IN MEMORY

This text is dedicated to Mr. Bob Sharpe, (1945-2002) a true professional who gave much of his life sharing the excitement of model rocketry and aerospace education with others. He was one of the best and he will be missed.

Dr. Ben Millspaugh

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Introduction

THE NEW CAP MODEL ROCKETRY PROGRAM

THE BASICS

This pamphlet was designed to be a transition from Module 4, *ROCKETS*, of Aerospace Dimensions, into the hobby and science of model rocketry. The author starts out with simple alternative-power models and progressively challenges the cadet with more advanced models.

This publication is about the basics. The author wants the cadet to understand the basics of rocket history, rocket science, rocket building, and the safe launch and recovery of a model rocket.

Launching and recovery takes only a few seconds but a large amount of the fun of model rocketry is in the construction and finishing. For this reason, the author has used "how-to" sequential photography to elaborate on the many accepted methods of building a quality model.

The program has been developed so that even the youngest cadets can participate in and have fun building inexpensive rockets. It has been created in three stages; Redstone, Titan and Saturn. Each stage is more challenging and, upon completion of the Saturn Stage, a cadet is eligible for the official Civil Air Patrol Model Rocketry Badge.

This program was also designed to include those cadets who live in areas where solid fuel rockets are against the law. Cadets in these circumstances are given the option of launching air-powered rockets.

This program has been designed to get cadets, qualified senior members and the squadron commander all working together. Upon completing this program, the cadet will be recognized by both peers and senior staff members as having leadership skills in the field of model rocketry.

National Standards

SCIENCE STANDARDS: National Research Council (NRC)

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Standard B: Physical Science

- Properties and changes of properties in matter
- Chemical reactions
- Motions and forces
- Transfer of energy

Standard E: Science and Technology

- Abilities of technological design
- Understandings about science and technology

Standard F: Science in Personal and Social Perspectives

- Risks and benefits
- Natural and human-induced hazards
- Science and technology in society

Standard G: History and Nature of Science

- Science as a human endeavor
- Historical perspectives
- History of science

Unifying Concepts and Processes

- Constancy, change, and measurement
- Evidence, models, and explanation
- Form and function

MATHEMATICS STANDARDS: National Council of Teachers of Mathematics (NCTM)

4. Measurement Standard

- Understand measurable attributes of objects and the units, systems, and processes of measurement.
- Apply appropriate techniques, tools, and formulas to determine measurements.

5. Data Analysis and Probability Standard

- Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.

6. Problem Solving Standard

- Solve problems that arise in mathematics and other contexts.

8. Communication Standard

- Use the language of mathematics to express mathematical ideas precisely.

9. Connections Standard

- Recognize and apply mathematics in contexts outside of mathematics.

TECHNOLOGY STANDARDS: International Technology Education Association (ITEA)

Standard 8: Understanding of the attributes of design.

Standard 10: Understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Standard 11: Ability to apply the design process.

SOCIAL STUDIES STANDARDS: National Council for the Social Studies (NCSS)

2. Time, Continuity, and Change
6. Power, Authority, and Governance
8. Science, Technology, and Society

Learning Outcomes

STAGE ONE - REDSTONE

After completing this stage, you should be able to:

- Identify historical facts about the development of rockets.
- Describe the major contributions of the four great rocket pioneers.
- Recall facts about the rocket pioneers' lives and accomplishments.
- Design, build and launch two non-solid fuel hands-on rocket options.

STAGE TWO - TITAN

After completing this stage, you should be able to:

- Explain Newton's three Laws of Motion.
- Describe the aerodynamics of a rocket.
- Design, build and launch two of the hands-on rocket options.
- Demonstrate knowledge of the NAR safety code.

STAGE THREE - SATURN

After completing this stage, you should be able to:

- Describe altitude tracking.
- Explain baseline distance.
- Describe the ingredients of a model rocket engine.
- Define Newton seconds.
- Define total impulse.
- Demonstrate knowledge of the NAR safety code.
- Design, build and launch one rocket in the Saturn stage.

The New Model Rocketry Program **Requirements**

STAGE ONE - Redstone

1. The Written Phase

The cadet must successfully pass a written examination on the history of rockets and the lives of four great rocket pioneers.

2. The Official Witness Log (OWL) and Testing

The cadet must have the squadron testing officer (STO) administer the required test, and sign the cadet's Official Witness Log (OWL).

3. The Hands-On Phase

The cadet is required to build two non-solid fuel rockets, with alternate sources of power. There are four options:

- (1) the rubber band powered Goddard rocket;
- (2) the AlkaSeltzer® and water rocket;
- (3) the rubber band junk rocket;
- (4) and the compressed air and water pop-bottle rocket.

4. The Official Witness Log (OWL) and Model Rocket Flights

The cadet must have a Qualified Senior Member (QSM) witness the launch of the two models, with alternate sources of power, and sign off the Official Witness Log (OWL). A Qualified Senior Member (QSM) may be any unit command staff member, or a currently registered Aerospace Education Member (AEM).

5. The Role of the Squadron Commander

After completion of all the above requirements, the cadet is entitled to the Redstone certificate. The Squadron Commander must review the completed Official Witness Logs and sign this certificate so the cadet may advance to the Titan stage. It is recommended that the certificate be presented at a squadron awards ceremony.

STAGE TWO - Titan

1. The Written Phase

The cadet must pass an examination on Newton's Laws of Motion and Rocket Aerodynamics.

2. The Official Witness Log (OWL) and Testing

The Squadron Testing Officer (STO) must administer the written test and sign the cadet's Official Witness Log (OWL).

3. The Hands-on Phase

- (1) The cadet is required to build two rockets in this stage: **One may be a commercial single-stage kit model powered by a commercial, solid fuel model rocket engine.** (The example used in the text is the Estes Alpha.)

- (2) **OR** In some states, model rockets are considered a fire hazard, or for other reasons, are outlawed. If this is the case, the cadet has the option to launch and safely recover a **commercial air-powered rocket**. If the cadet chooses this option, he/she must give mathematical proof of the altitude achieved in the flight. This can be done using an astrolabe (as featured on page 29 in *Aerospace Dimensions, Rockets, Module 4*), or one of the commercial altitude finders such as the Estes Altitrak®.
- (3) If the cadet lives in an area where rockets are allowed, he/she is required to build a single-stage model rocket **that is a scale reproduction of an actual rocket from Aerospace history**. (The example given in the text is the Estes Redstone.)
- (4) **If the cadet lives in an area where rockets are outlawed, a plastic scale model of an actual rocket, from aerospace history, may be built and presented to the QSM.** Rockets like the V-2, Redstone, Nike, Sidewinder, etc. are examples of scale models. Models from "sci-fi" movies, or TV series, do not count.

4. The Official Witness Log (OWL) for Construction and Flight of Rockets.

The cadet must prove, before flight, that the models are stable. The cadet may use the swing test described in the text for proof of stability. A Qualified Senior Member (QSM) must then witness the successful launch, flight and recovery of the model rockets required in this phase. **It is the responsibility of the Qualified Senior Member (QSM) to see that the NAR SAFETY CODE guidelines are followed in all model rocket launches. The cadet must demonstrate NAR Safety Code Proficiency, follow a set pre-flight checklist, and execute the launch and recovery with safety.** If the QSM feels that the cadet has been responsible in all areas of the NAR safety code, then he/she may sign the OWL for this phase.

5. The cadet must have a working knowledge of the NAR SAFETY CODE and give proof of this during all launches.

6. The Role of the Squadron Commander

After completion of all the above requirements, the cadet is entitled to the Titan certificate. The Squadron Commander must review the completed Official Witness Logs and sign this certificate so the cadet may advance to the Titan stage. It is recommended that the certificate be presented at a squadron awards ceremony.

STAGE THREE - Saturn

1. The Written Phase

- a. The cadet is required to pass an examination on how to determine a model rocket's altitude at the apogee of its flight.
- b. The cadet is required to pass a second component of the written examination that covers model rocket engines.
- c. **The cadet is to have a working knowledge of the NAR safety code.**

2. The Official Witness Log and Testing

The squadron testing officer must administer the test and hear the recitation of the NAR Safety Code.

3. The Hands-On Phase

The cadet is required to build **ONE** rocket in the Saturn Stage.

- a. The cadet **MAY ELECT TO BUILD** a two-stage rocket that requires two engines to reach altitude. The rocket must reach at least 500' and be safely recovered.
- b. **OR** the cadet may elect to build a model rocket that is capable of carrying at least a 3-ounce payload to an altitude of 300' or more.
- c. **OR** the cadet may elect to build a model rocket that has a separate glider attachment. The glider and rocket must return to earth safely and within NAR safety code guidelines.

- d. **OR, if the cadet lives in an area where solid-fuel model rockets are outlawed, he/she may elect to build an air-powered rocket of his/her own design from scratch. It may be launched by a commercial launcher such as the Estes or Air Burst.** If this is the case, the cadet must give proof of the altitude attained, by the scratch-built model, using an astrolabe or a commercial model such as the Estes Astrotrak®. This must be verified by the QSM as part of the OWL sign-off.

4. The Official Witness Log For Flight and Recovery of the Models

A qualified senior member (QSM) must witness the launch and safe recovery of the rocket. All of the NAR Safety Guidelines must be followed and the Official Witness Log (OWL) must be signed by the QSM after these flights.

5. The Role of the Squadron Commander.

The squadron commander is required to sign the OWLs for the Saturn stage. After completion of this stage, the cadet is entitled to receive the official CAP Model Rocketry Badge. It is recommended that this honor be given to the cadet at a squadron awards ceremony.