

Team America Rocketry Challenge Summer Academy

Description

This two week camp is designed to teach the skill necessary for middle and high school students to successfully compete in the Team America Rocketry Challenge.

Student Outcomes

Student outcomes of this course are:

- Know the history and background of the TARC and understand the challenges and goals of the contest.
- Understand Newton's Laws of Motion and how to apply them in the design, construction, and flight of their rocket.
- Understand the four forces of flight (Lift, Drag, Thrust, and Gravity) and how they affect rocket flight. The students will also learn how to manipulate each force to improve rocket performance.
- Understand the importance, relationship, and manipulation of the centers of pressure and gravity of a model rocket.
- Know about the history of model rocketry from its earliest beginnings to the present.
- Know the parts of a typical model rocket as well as unusual configurations.
- Know about the National Association of Rocketry and its importance to model rocketry.
- Know the Model Rocketry Rules.
- Have a working knowledge of the RockSim computer program in order to design a model rocket and run accurate flight simulations. In addition, each student will learn how to use the program to make adjustments to their rocket during the test flight stage.
- Know how to build and fly a model rocket. Instruction will cover:
 - **The Payload Model Rocket in Detail**
 - Epoxy, ca glue, and wood glues
 - Booster Section
 - Fin design and construction materials
 - Engine mount design and construction
 - Through the Tube Fins (TTF)
 - Fin Fillets
 - Shock cords and their attachment
 - Launch rods and rails: the pros and cons
 - Payload Section
 - Nose cone designs, materials, and selection
 - Airframe sizes and selection
 - Bulkheads
 - Egg compartment materials
 - Altimeter bay
 - Altimeter installation and operation
 - Shock cord attachment
 - Painting and Finishing
 - Priming
 - Sanding and wet sanding

- Painting
 - Designing and printing decals
 - Rocket Motors
 - Rating system and reading thrust curves
 - Black powder verses composite motors
 - Single use verses reloadable
 - How to build a reloadable engine
 - Ignition systems
 - Parachutes and Recovery
 - Types of recovery systems
 - Parachute types and sizes
 - Spill holes
 - Determining the right parachute
 - Parachute attachment
 - Running parachute simulations in RockSim
 - Parachute protection techniques
- **Launching a Model Rocket**
 - Launch pad selection
 - Ignition systems
 - Launch site selection
 - Model rocket safety rules
- **The collection, Interpretation, and Use of Flight Data**
 - Types and methods of data collection
 - Interpreting flight data
 - Making adjustments to rocket

DAY 1

Lesson 1: Introduction to the Team America Rocketry Challenge

- Issuance of Handbooks
- Overview of camp
- TARC history and challenges
- TARC video

REQUIREMENTS: PowerPoint presentation, video of finals, computer, projector, sound system

LOCATION: Classroom

TIME REQUIRED: 2 hours

Lesson 2: The Model Rocket

DESCRIPTION: With the aid of a PowerPoint presentation and handouts, the students will learn:

- The history of model rocketry
- The parts of a model rocket including its propulsion and recovery system
- The National Association of Rocketry
- Model Rocketry Rules

REQUIREMENTS: PowerPoint presentations on the topics, computer and projector, Student Handbook.

LOCATION: Classroom

TIME REQUIRED: 2 hours

DAY 2

Lesson 3: The Laws of Motion and Aerodynamics

DESCRIPTION: The students will be given instruction on Newton's Laws of Motion and Aerodynamics as it pertains to model rockets. These lessons will reinforce all other lessons given in the Academy. Topics will include:

- Newton's three Laws of Motion
- Four Forces of Flight; lift, thrust, drag, and gravity
- Roll, pitch and yaw
- Center of Pressure
- Center of Gravity
- One Caliber Stability

REQUIREMENTS: PowerPoint presentations on the topics, computer and projector, Student Handbook.

LOCATION: Classroom

TIME REQUIRED: 2 hours

DAY 3

Lesson 5: RockSim

DESCRIPTION: Students will learn use the RockSim model rocket software program.

- The RockSim interface
- Step by step build of a basic model rocket with payload section.
- Selecting and loading an engine
- Flight simulations

REQUIREMENTS: one computer with an installed copy of RockSim for every one to two students.

LOCATION: Computer Lab

TIME REQUIRED: 4 Hours

DAY 4

Lesson 6: The Booster Section

DESCRIPTION: The instructor will have examples of booster section parts and lead the class in a discussion about each one of them. The students will learn:

- DESCRIPTION: The students will learn:
- Fin design and construction
- Engine mount design and construction
- How to select and use epoxy and other adhesives
- Through the Tube Fins (TTF)
- Shock cords and their attachment
- Launch rods and rails: the pros and cons

REQUIREMENTS: fin material, 24mm and 29mm engine mounts, assortment of epoxy, rubber gloves and protective equipment, assortment of shock cord material, hardware, launch lugs and buttons, launch rail and rod systems.

LOCATION: Classroom

TIME REQUIRED: 2 Hours

Model Rocket Build 1

DESCRIPTION: The students will begin construction of a basic egg payload rocket kit such as the Quest Courier.

REQUIREMENTS: Model rocket kit for each student, building materials

LOCATION: Classroom

TIME REQUIRED: 2 Hours

DAY 5

Lesson 7: Payload Section

DESCRIPTION: The instructor will have examples of payload section part and lead the class in a discussion about each one of them. The students will learn:

- Nose cone selection and installation
- Everything you ever wanted to know about chicken eggs.
- Egg payload section and packing materials
- Perfectflight ALT15 Altimeter operation
- Electronics payload section (location, vent holes, activation methods)
- Demonstration flight with electronic altimeter

REQUIREMENTS: nose cone examples of various materials, shapes, and sizes, BT70, BT80, BT80H, and T300 body tubes, chicken eggs, floral foam, packing peanuts, sponge foam, Perfectflight altimeters, Perfectflight software, activation switches, hardware, demonstration rocket and launch equipment.

LOCATION: Classroom/field

TIME REQUIRED: 2 Hours

Model Rocket Build 2

DESCRIPTION: The students will continue construction of a basic payload rocket.

REQUIREMENTS: Model rocket kit for each student, building materials

LOCATION: Classroom

TIME REQUIRED: 2 Hours

DAY 6

Lesson 9: Finishing a model rocket

Student will learn the process of creating an aerodynamic finish on their TARC rocket, which will include information on:

- Wood sealers and fillers
- Paint primers
- Sanding and wet sanding techniques
- Paint applications
- Clear coats and polish
- REQUIREMENTS: Finishing materials
- LOCATION: Classroom
- TIME REQUIRED: 1 Hour

Model Rocket Build 3

DESCRIPTION: The students will continue construction of a basic payload rocket.

REQUIREMENTS: Model rocket kit for each student, building materials

LOCATION: Classroom

TIME REQUIRED: 3 Hours

DAY 7

Lesson 10: Engines and Parachutes

DESCRIPTION: The students will learn how to select the proper engine and parachute for the challenge. Lessons will include:

- The types of available rocket engines
- Single use and reloadable engines
- how to read a thrust curve
- how to build a reloadable engine, engine retainer systems
- clustering
- staged rockets
- The types of recovery systems
- Choosing the right parachute
- Dual recovery methods

REQUIREMENTS: Examples of rocket engines and parachutes, examples of rockets using clustering and staging, examples of retaining systems.

LOCATION: Classroom

TIME REQUIRED 2 Hours

Model Rocket Build 4

DESCRIPTION: The students will continue construction of a basic payload rocket.

REQUIREMENTS: Model rocket kit for each student, building materials

LOCATION: Classroom

TIME REQUIRED: 2 Hours

DAY 8

Launch Day 1

DESCRIPTION: The students will

- Prep rockets for flight (classroom):
 - Review NAR Safety code.
 - Install engine and recovery system
 - Install payload
 - Weigh fully loaded rocket and determine center of gravity

- Launch procedures (field)
 - Set up launch equipment
 - Take and record wind speed, humidity, and air pressure
 - Launch rockets and collect data on altitude and total time of flight
- Post launch procedures (field or classroom)
 - Collect and record data to include altitude, time of flight, recovery system, flight characteristics (pitch & roll, weathercocking), and meteorology readings.
 - Discuss with students the flight of the rocket following Newton's Laws of Motion
 - Record data in RockSim and compare simulations with actual flight
 - Make adjustments to RockSim to match actual flights

REQUIREMENTS: Completed student rockets, C6 engines, parachutes (with and without spillholes), scale, launch equipment, Estes Altitrak (2), Stopwatches, pocket anemometer, sling psychrometer, barometer, Flight Log, RockSim installed on a laptop

LOCATION: Field

TIME REQUIRED: 2-4 Hours

DAY 9

Launch Day 2

DESCRIPTION: Using Newton's Second Law of Motion, $F = MA$, the students will make adjustments to their rockets in order to reduce the altitude in a predicable manner:

- Prep rockets for flight (classroom):
 - Install engine and recovery system
 - Determine weight to lower altitude by 25% by adding clay
 - Install payload
 - Weigh fully loaded rocket and determine center of gravity
- Launch procedures (field)
 - Set up launch equipment
 - Take and record wind speed, humidity, and air pressure
 - Launch rockets and collect data on altitude and total time of flight
- Post launch procedures (field or classroom)
 - Collect and record data to include altitude, time of flight, recovery system, flight characteristics (pitch & roll, weathercocking), and meteorology readings.
 - Discuss with students the flight of the rocket following Newton's Laws of Motion
 - Record data in RockSim and compare simulations with actual flight
 - Make adjustments to RockSim to match actual flights

REQUIREMENTS: Completed student rockets, modeling clay, C6 engines, parachutes (with and without spillholes), scale, launch equipment, Estes Altitrak (2), Stopwatches, pocket anemometer, sling psychrometer, barometer, Flight Log, RockSim installed on a laptop

LOCATION: Field

TIME REQUIRED: 2-4 Hours

DAY 10

Mini TARC competition

DESCRIPTION: The students will compete to simulate TARC qualifications and finals. Based on experience gained by the previous flights, each student will make adjustments to their rocket to meet a target altitude and total time of flight.

- Prep rockets for flight (classroom):
 - Install engine and recovery system
 - Adjust rocket by adding or removing clay
 - Install payload
 - Weigh fully loaded rocket and determine center of gravity
- Launch procedures (field)
 - Set up launch equipment
 - Take and record wind speed, humidity, and air pressure
 - Launch rockets and collect data on altitude and total time of flight
- Post launch procedures (field or classroom)
 - Collect and record data to include altitude, time of flight, recovery system, flight characteristics (pitch & roll, weathercocking), and meteorology readings.
 - Discuss with students the flight of the rocket following Newton's Laws of Motion
 - Record data in RockSim and compare simulations with actual flight
 - Make adjustments to RockSim to match actual flights

REQUIREMENTS: Completed student rockets, modeling clay, C6 engines, parachutes (with and without spillholes), scale, launch equipment, Estes Altitrak (2), Stopwatches, pocket anemometer, sling psychrometer, barometer, Flight Log, RockSim installed on a laptop

LOCATION: Field

TIME REQUIRED: 2-4 Hours

Concluding Activities