

Rockets!:

A Study of Forces, Newton's Laws of Motion, And Aerodynamics

IEEE ARIZONA SCIENCE LAB®
www.arizonasciencelab.org

Workshop Focus:

The workshop focuses on aerospace engineering and how space flight has been achieved from an engineering vantage point. Students build and launch a model bottle (water) rocket and consider the forces on a rocket, Newton's Laws, rocket stability, and other principles and challenges of actual space vehicle launch. They design their structure on paper, learn about aerospace engineering, launch their rocket, measure the altitude it reaches, and share observations with their class.

Workshop Synopsis:

The Rockets workshop explores rocketry, and the principals of space flight. Students work in teams of two “engineers” and construct and launch a bottle rocket constructed from a soda bottle and other everyday items. They measure the altitude their rocket reaches by timing the descent from apogee. They observe their own achievements and challenges, as well as those of other student teams, and present their experiences to the class.

Age Levels:

8 – 15 years (grades 4 – 8)

Objectives:

- Learn about Newton's Three Laws of Motion
- Learn about rocket stability, center of mass and center of pressure

- Learn about aerospace engineering
- Learn about engineering design and redesign
- Learn about space flight
- Learn how engineering can help solve society's challenges
- Learn about teamwork and problem solving

Anticipated Learner Outcomes:

As a result of this activity, students should develop an understanding of:

- aerospace engineering
- engineering design
- space flight
- teamwork

Lesson Activities:

Students explore how engineers have developed rocket ships over the years, and learn about the principals of rocketry. They work in teams of two “engineers” to design, construct and launch a bottle (water) rocket from a soda bottle and various everyday materials. The students measure the altitude their rocket reaches by timing the descent from apogee, compare their accomplishments and challenges with those of other student teams, and present to the class.

Alignment to Curriculum Frameworks:

Note: All Arizona Science Lab workshops are aligned to the National Science Education Standards which were produced by the National Research Council and endorsed by the National Science Teachers Association, and if applicable, also to the International Technology Education Association's Standards for Technological Literacy or the National Council of Teachers of Mathematics' Principals and Standards for School Mathematics. They will also be modified as necessary to be aligned to the Next Generation Science Standards (NGSS) when they are released.

• National Science Education Standards Grades K-4 (ages 4-9)

CONTENT STANDARD A: Science as Inquiry As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop understanding of

- Motions and forces

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Abilities of technological design
- Understandings about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Science and technology in local, national, and global challenges

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- Science as a human endeavor
- Nature of scientific knowledge
- Historical perspectives

• **Standards for Technological Literacy - All Ages**

The Nature of Technology

- Standard 1: Students will develop an understanding of the characteristics and scope of technology.

Technology and Society

- Standard 6: Students will develop an understanding of the role of society in the development and use of technology
- Standard 7: Students will develop an understanding of the influence of technology on history

Design

- Standard 8: Students will develop an understanding of the attributes of design
- Standard 9: Students will develop an understanding of engineering design
- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving

Abilities for a Technological World

- Standard 11: Students will develop abilities to apply the design process.

Internet Connections

- TryEngineering (www.tryengineering.org)
- Timeline of Rocket History (<http://history.msfc.nasa.gov/rocketry/>)
- NASA Beginners Guide to Rockets (www.grc.nasa.gov/WWW/K-12/rocket/bgmr.html)
- European Space Agency - Space Engineering (www.esa.int/SPECIALS/Space_Engineering)

- Rocketry Planet (www.rocketryplanet.com)
- National Science Education Standards (www.nsta.org/publications/nse.aspx)
- ITEA Standards for Technological Literacy (www.iteaconnect.org/TAA)

Recommended Reading:

- Rockets and Missiles: The Life Story of a Technology (ISBN: 978-0801887925)
- Rocket and Spacecraft Propulsion: Principles, Practice and New Developments (ISBN: 978-3642088698)
- It's ONLY Rocket Science (ISBN: 978-0387753775)
- "A Pictorial History of Rockets" (www.nasa.gov/pdf/153410main_Rockets_History.pdf)

Materials and Tools:

All materials and tools required for this workshop are provided by the Arizona Science Lab

Time Needed:

One four hour workshop (inclusive of lunch and restroom breaks).

ASL Staff Responsibilities:

The ASL staff is responsible for the conduct of the workshop:

- Setting up the workshop
- Presenting the lecture and teaching the science
- Performing the demonstrations
- Provisioning the materials and equipment to the student teams
- Supervising the construction project
- Supporting the students during the construction project
- Supervising the project testing
- Answering student questions about the science, the workshop, or any other related topic
- Cleaning up the workshop after the students have left

School Teacher Responsibilities:

- **Managing the students during the class and the lunch and restroom breaks, and imposing discipline as necessary**
 - The ASL staff is NOT responsible for the class management or for student discipline!
 - **The restroom breaks will require at least one male and one female teacher be present from the school**
- Assisting the ASL staff in the teaching of the science
 - This could comprise asking the students questions about what had just been explained,

presenting what had just been explained in another fashion, and so on

- The ASL staff are not necessarily trained teachers and the school teachers know their students very well, so they can provide valuable insights and help to the ASL staff
- Assisting the ASL staff during the project construction and testing