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QuickView

Students design and conduct an experiment to determine the load capacity of a parachute.

Standards Addressed

NSTA 5-8

Students develop abilities necessary to do scientific inquiry.

- Students identify questions that can be answered through scientific investigations.
- Students design and conduct a scientific investigation.
- Students use appropriate tools and techniques to gather, analyze, and interpret data.
- Students think critically and logically to make the relationships between evidence and explanations.
- Students communicate scientific procedures and explanations.
- Students use mathematics in all aspects of scientific inquiry.

Students develop understandings about scientific inquiry.

- Students understand different kinds of questions suggest different kinds of scientific investigations and some investigations involve observing and describing objects, organisms, or events, some involve collecting specimens, some involve experiments, some involve seeking more information, some involve discovery of new objects and phenomena, and some involve making models.
- Students understand mathematics is important in all aspects of scientific inquiry.
- Students understand technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations.

Students develop an understanding of motions and forces.

- Students understand the motion of an object can be described by its position, direction of motion, and speed and that motion can be measured and represented on a graph.

Students develop abilities for technological design.

- Students evaluate completed technological designs or products.
- Students communicate the process of technological design.

NCTM 6-8

Students understand numbers, ways of representing numbers, relationships among numbers, and number systems.

- Students work flexibly with fractions, decimals, and percents to solve problems.

Students use mathematical models to represent and understand quantitative relationships.

- Students model and solve contextualized problems using various representations, such as graphs, tables, and equations.

Students understand measurable attributes of objects and the units, systems, and processes of measurement.

- Students understand both metric and customary systems of measurement.

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

- Students select, create, and use appropriate graphical representations of data, including histograms, box plots, and scatterplots.

Students solve problems that arise in mathematics and in other contexts.

Students select, apply, and translate among mathematical representations to solve problems.

Students use representations to model and interpret physical, social, and mathematical phenomena.

ITEA 6-8
Students develop an understanding of the core concepts of technology.

- Students learn that systems thinking involves considering how every part relates to others.
- Students learn that malfunctions of any part of a system may affect the function and quality of the system.

Students develop an understanding of the attributes of design.

- Students learn that design is a creative planning process that leads to useful products and systems.
- Students learn that requirements for design are made up of criteria and constraints.

Students develop an understanding of engineering design.

- Students learn that modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.

Students develop an understanding of the role of troubleshooting, research and development, invention and innovation and experimentation in problem solving.

- Students learn that some technological problems are best solved through experimentation.

NCTE K-12
Students read a wide range of print and nonprint texts to build an understanding of texts, of themselves, and of the cultures of United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment.

Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts; they draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies, and their understanding of textual features.

Students adjust their use of spoken, written, and visual language to communicate effectively with a variety of audiences and for different purposes.

Students use spoken, written, and visual language to accomplish their own purposes.

Time Required

45 minutes (will vary with class size)

Content Areas

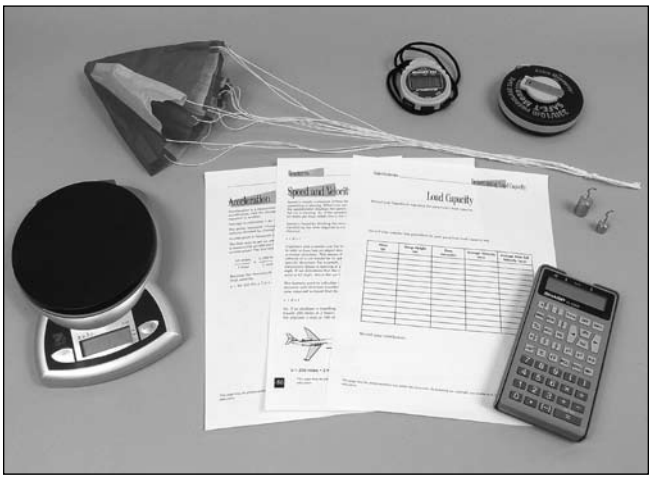
Primary: Science
Secondary: Technology, language arts

Vocabulary

- acceleration
- capacity
- load
- mass
- speed
- velocity

Materials

- Completed parachute
- Hooked mass set
- Stopwatch
- Tape measure (metric)
- "Speed and Velocity" resource page
- "Acceleration" resource page
- "Load Capacity" worksheet
- Calculator
- Digital scale or digital balance (optional)



Procedure

1 Locate a completed parachute and a hooked mass set. You may use a parachute you constructed from gore panels, a parachute made from a single piece pattern, a premade parachute, or a parachute made from your own design. The parachute used for this activity should be model size, appropriate for model rocket or similarly sized items.

The instructions for constructing a parachute using the gore pattern are provided in the Construction QuickView. You may also use a parachute pattern such as the Pitsco parachute found in the Pitsco Advanced Recovery System or in one of Pitsco's solid-fuel or water bottle rocket kits.

2 Read the "Speed and Velocity" and "Acceleration" resource pages.

3 The load capacity of the parachute is defined as the amount of mass the parachute can carry to the ground while slowing its average descent velocity to half the average free fall velocity. You will be determining the load capacity of the parachute.

4 Conduct initial tests of the parachute by attaching various masses to its shroud lines and dropping the masses from heights of 1 meter to 1.1 meters. Observe the performance of the parachute with the various masses attached.

These tests are best conducted over carpet or a soft surface for landing.

5 Based on your observations, form a hypothesis that describes the load capacity of the parachute. Record the hypothesis on the "Load Capacity" worksheet.

The students' hypotheses must be testable and specific regarding the load capacity of the parachute.

6 Design and conduct an experiment to determine the load capacity of the parachute. On the "Load Capacity" worksheet, write a step-by-step procedure for the test that provides enough detail so that the test could be repeated by a person using your instructions. These procedures should include the height from which the parachute will be dropped. For best results, the height should be at least 2.2 meters.

You should test the parachute according to the student's procedure, or have students test the parachute using each other's procedures to determine the adequacy of the instructions.

7 Calculate the average free fall velocity of an object dropped from the height used in your procedure. To do this, calculate the time of descent using the formula and process described in the "Speed and Velocity" and "Acceleration" resource pages.

Students use the formula $t = \sqrt{2d/a}$. Students will likely need to use a calculator to calculate the square root.

8 Conduct the test. On the "Load Capacity" worksheet, record the time of descent and average velocity of the various masses tested.

Students divide distance by the time of travel to determine the average velocity.

9 Write a conclusion explaining your findings and evaluating your hypothesis.

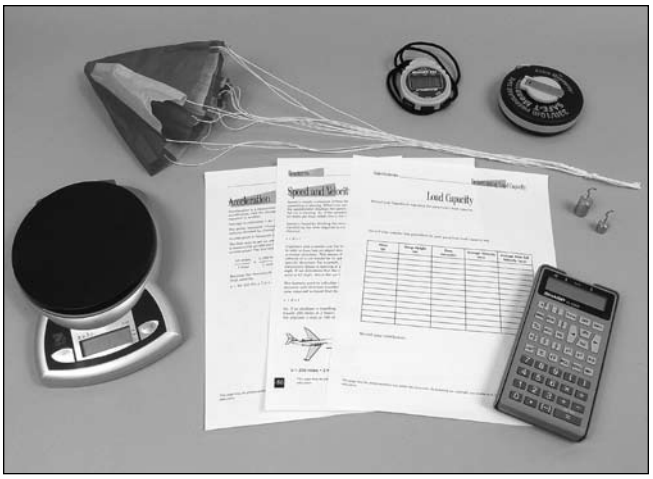
Students' conclusions must include actual load capacity. If the load capacity is substantially different from the hypothesis, then the students should explain why.

QuickView

Design and conduct an experiment to determine the load capacity of a parachute.

Materials

- Completed parachute
- Hooked mass set
- Stopwatch
- Tape measure (metric)
- "Speed and Velocity" resource page
- "Acceleration" resource page
- "Load Capacity" worksheet
- Calculator
- Digital scale or digital balance (optional)



Procedure

1 Locate a completed parachute and a hooked mass set. You may use a parachute you constructed from gore panels, a parachute made from a single piece pattern, a premade parachute, or a parachute made from your own design. The parachute used for this activity should be model size, appropriate for model rocket or similarly sized items.

2 Read the "Speed and Velocity" and "Acceleration" resource pages.

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5 Based on your observations, form a hypothesis that describes the load capacity of the parachute. Record the hypothesis on the "Load Capacity" worksheet.

6 Design and conduct an experiment to determine the load capacity of the parachute. On the "Load Capacity" worksheet, write a step-by-step procedure for the test that provides enough detail so that the test could be repeated by a person using your instructions. These procedures should include the height from which the parachute will be dropped. For best results, the height should be at least 2.2 meters.

7 Calculate the average free fall velocity of an object dropped from the height used in your procedure. To do this, calculate the time of descent using the formula and process described in the "Speed and Velocity" and "Acceleration" resource pages.

8 Conduct the test. On the "Load Capacity" worksheet, record the time of descent and average velocity of the various masses tested.

9 Write a conclusion explaining your findings and evaluating your hypothesis.

Load Capacity

Record your hypothesis regarding the parachute's load capacity.

Record your step-by-step procedure for your parachute load capacity test.

Mass (g)	Drop Height (m)	Time (seconds)	Average Velocity (m/s)	Average Free Fall Velocity (m/s)

Record your conclusions.