Newton's Toy Box

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About **Newton's Toy Box**

DeltaScienceModules, THIRD EDITION

Students experiment freely with familiar toys and objects. As they explain their observations, they prove Newton's three laws of motion. The path of a tossed ball, the flip of a grasshopper toy, and the endless swing of clackers reinforce the concepts of inertia, gravity, acceleration, mass, force, and momentum. Students engage in races, games, and challenges that emphasize the laws of motion, which govern everyday tasks and cosmic interactions. The kit includes a video so students can compare the behavior of the toys on Earth with their behavior in a microgravity environment. By dealing with scaled-down applications, middle school students grasp these laws and master the vocabulary of physics.

In the Delta Science Reader *Newton's Toy Box,* students delve into the basic physics of motion. They find out how motion is described in terms of distance, direction, motion, speed, velocity, and acceleration. They discover the effects of friction and gravity on objects and read about conservation of momentum. Newton's laws of motion are explained and illustrated so that students can comprehend how and why objects move, or don't. Students also investigate the relationship among force, energy, power, and work and then explore the devices that make work easier. They learn how the six simple machines provide a mechanical advantage, such as multiplying input force, and how the efficiency of simple and compound machines is calculated. In a biographical sketch, they are introduced to Sir Isaac Newton. They also read about satellite motion—how satellites are placed in orbit and how they stay there.

Overview Chart for Hands-on Activities

Hands-on Activity	Student Objectives
1 **Motion in Review** *page 13*	• observe that an object at rest remains at rest until a force acts on it • describe the motion of an object when it experiences a force
2 **Gravity and Balance** *page 19*	• identify gravity as the force that makes an object fall • measure the strength of the gravity force on an object • compare gravity and gravity support forces
3 **Moving Masses** *page 25*	• describe the relationship between mass and weight • observe the relationship between force and acceleration • observe the relationship between force and mass • predict the falling rate of balls of different masses
4 **The Parachute Drop** *page 33*	• observe the effects of air resistance on falling objects • use air resistance to slow the speed of a falling object • compare the parachute requirements for objects of different masses
5 **Basketball Arcs** *page 39*	• observe the trajectory of a thrown ball • apply what they observe to the game of basketball • predict how the ball would behave in a microgravity environment
6 **Ball and Cup Contest** *page 45*	• observe the path of a circling ball • describe how gravity is used to catch the ball • predict how the toy can be operated in a microgravity environment
7 **Rolling On** *page 49*	• measure the distance traveled and the elapsed time for a moving object • calculate the speed of a moving object • observe how the speed of a moving object changes on different surfaces
8 **Great Race** *page 55*	• calculate the average speed of a car rolling down a ramp • compare the speed of a car to its starting height on the ramp • relate gravitational potential energy to kinetic energy
9 **Accelerating Masses** *page 61*	• observe the acceleration of a car rolling down a ramp • calculate the average speed of the car at two different points on the ramp • determine whether the car is accelerating
10 **The Come-Back Can** *page 67*	• construct a come-back can • predict what will happen to the can when it is rolled forward • demonstrate how energy is conserved in a come-back can
11 **Action-Reaction in Action** *page 73*	• identify the action and reaction forces when a ball bounces • predict the behavior of a spring jumper on the basis of action-reaction forces
12 **The Grasshopper Game** *page 79*	• describe the action and reaction forces involved in a flipping paper grasshopper • compare the jumping ability of paper grasshoppers of different masses
13 **Clacker Conservation** *page 85*	• observe and identify action and reaction forces that cause the clacker to behave as it does • identify momentum conservation behaviors in clackers that demonstrate that momentum is conserved • predict which clacker behaviors will be possible in microgravity
Assessment *page 91*	• See page 91.

Process Skills	Vocabulary	Delta Science Reader
observe, investigate, communicate	**force, inertia, Newton's first law of motion, velocity**	pages 2–3, 4, 10–11, 22
observe, measure, compare, record data, use numbers	**gravity, gravity support force, newton (N), pound (lb), weight**	pages 4–5, 8
communicate, measure, record data, conclude, observe, predict	**acceleration, mass, Newton's second law of motion**	pages 4–5, 8, 12, 22
observe, hypothesize, experiment, use variables, predict, compare	**air resistance**	pages 6–8
observe, experiment, predict	**free fall, parabola**	page 23
collect data, experiment, conclude, predict	**microgravity**	page 23
measure, collect and record data, use numbers, interpret data, conclude, define based on observations	**distance, friction, speed, time**	pages 3, 6–7
measure, collect and record data, use variables, use numbers, interpret data, communicate, compare	**energy, gravitational potential energy, kinetic energy, potential energy**	pages 3, 14
measure, observe, collect and record data, use numbers, interpret data, conclude		pages 4–5
investigate, observe, communicate, infer, predict	**conservation of energy, elastic potential energy**	page 14
observe, experiment, use variables, collect and record data, predict, define based on observations	**action force, Newton's third law of motion, reaction force**	pages 13, 22
observe, predict, communicate, compare		page 13
observe, analyze data, predict	**conservation of momentum, momentum**	page 9

See the following page for the Delta Science Reader Overview Chart.

Overview Chart for Delta Science Reader *Newton's Toy Box*

Selections	Vocabulary	Related Activity
Think About...		
Motion and Speed *pages 2–3* • Changing Position • Speed and Velocity	**average speed, displacement, distance, motion, position, reference point, speed, velocity**	Activity 1
Forces and Motion *pages 4–9* • What Are Forces? • How Do Forces Affect Objects? • What Is Friction? • What Is Gravity? • What Is Momentum?	**acceleration, air resistance, balanced forces, force, friction, gravity, law of conservation of momentum, mass, momentum, net force, newton, terminal velocity, unbalanced forces, weight**	Activities 2, 3, 7, 8, 9, 13
Newton's Laws of Motion *pages 10–13* • Newton's First Law • Newton's Second Law • Newton's Third Law	**inertia, Newton's first law of motion, Newton's second law of motion, Newton's third law of motion**	Activities 1, 3, 11, 12
Work, Energy, and Power *page 14*	**energy, joule, kinetic energy, potential energy, power, work**	Activities 8, 10
Machines and Work *pages 15–21* • Mechanical Advantage • Efficiency • Simple Machines • Compound Machines	**compound machine, efficiency, fulcrum, gear, inclined plane, input force, lever, machine, mechanical advantage, output force, pulley, screw, simple machine, wedge, wheel and axle, work input, work output**	
People in Science		
• **Sir Isaac Newton** *page 22*	**law of universal gravitation**	Activities 1, 2, 3, 11
Did You Know?		
• **About Satellite Motion** *page 23*	**free fall, satellite**	Activities 4, 5, 6, 10, 13

Teaching suggestions for the Delta Science Reader are in a 32-page booklet included with this guide.

MATERIALS LIST

Newton's Toy Box

Quantity	Description
8	bags, mesh, for spring scale
1	balance ball set
8	balls and hoops
8	balls, steel
17	balls, table tennis
16	balls, wooden
8	cars
16	clackers
1	Come-Back Can Instructions
12	connectors
17	cups, paper, 3-oz
1	Delta Science Dictionary
1	Delta Science Dictionary Copymaster Booklet
1	Grasshopper Instructions
1	Grasshopper Patterns
10	hex nuts
10	jars, plastic, with hole
10	lids for jars, with hole
1	paper clips, p/100*
16	parachute sheets*
1	poster, Building Science Vocabulary
1	poster, Measurement Resources
1	poster, Science Safety
1	rubber bands, p/60
8	scales, spring
16	spring jumpers
17	sticks, wooden, flat
8	stopwatches
1	string, kite, 250-ft roll
4	tape, masking, rolls*
8	tapes, measuring
16	tracks
1	videotape, *Toys in Space*
1	**Teacher's Guide**
8	**Delta Science Readers**

Quantity	Description
TEACHER-PROVIDED ITEMS	
32	books, hardcover
1	calculator (optional)
1	chalk piece (optional)
16	paper, white, sheets
32	pennies
16	rulers or meter sticks
1	scale, bathroom (optional)
32	scissors
8	towels, friction
1	VCR and monitor

* = consumable item   † = in separate box

ACTIVITY SUMMARY

In this Delta Science Module, students are introduced to many fundamental concepts in physics as they experiment freely with familiar toys and objects and then are asked to define what they observe in terms of Newton's three laws of motion.

ACTIVITIES 1, 2, and 3 Students review gravity, motion, and the relationship between mass and force. They observe simple behaviors and then define them using the terms *motion, force, mass, velocity, inertia, gravity*, and *acceleration*.

ACTIVITY 4 Students continue to explore the laws of motion. They investigate the variables that affect air resistance when they construct a parachute and use it to slow the speed of falling objects.

ACTIVITY 5 Students examine the parabolic path of a tossed ball. While playing the familiar game of basketball, students recognize just how they manipulate the angle of the arc in order to correctly position where the ball will fall.

ACTIVITY 6 Students experiment with the traditional "ball and cup" and then explain how gravity and Newton's second law affect the toy.

ACTIVITY 7 Students reexamine Newton's first law when they observe, and then define, the force that opposes the forward motion of a moving object—friction. Students calculate the speed of a toy car in three different situations and then identify the degree of friction as the variable that accounts for the differences in speed.

ACTIVITY 8 Students accelerate their toy cars by elevating the track to form a ramp. As the cars descend the ramp, their gravitational potential energy (due to position) is converted to kinetic energy (in the form of motion). Students vary the elevation of the ramp and then measure the resultant speeds of the descending cars using stopwatches.

ACTIVITY 9 Students measure the actual acceleration of their cars as they descend the ramp.

ACTIVITY 10 Students explore Newton's third law of motion—action and reaction—with a come-back can, a simple device that stores and then releases energy. Students construct the cans, observe their behavior, and then describe it in terms of potential and kinetic energy.

ACTIVITIES 11 and 12 Students continue to examine action and reaction by way of spring jumpers and student-assembled paper models of grasshoppers.

ACTIVITY 13 Students demonstrate conservation of momentum, another way of looking at Newton's third law, using free-hanging objects. They experiment with another popular toy, the clacker, and describe its behavior in terms of momentum and transfer of energy.

In conjunction with the activities they perform, students watch a video in which astronauts experiment with some of the same toys that students are experimenting with. Students compare the behavior of the toys on Earth with the behavior of the toys in a microgravity environment and see that many of the techniques they use to operate their toys here on Earth depend on Earth's gravitational force.