Physics in Motion

STEM Road Map for Elementary School

Grade K

Edited by Carla C. Johnson, Janet B. Walton, and Erin Peters-Burton

NSTA press
National Science Teaching Association

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Dr. Erin Peters-Burton is the Donna R. and David E. Sterling endowed professor in science education at George Mason University in Fairfax, Virginia. She uses her experiences from 15 years as an engineer and secondary science, engineering, and mathematics teacher to develop research projects that directly inform classroom practice in science and engineering. Her research agenda is based on the idea that all students should build self-awareness of how they learn science and engineering. She works to help students see themselves as "science-minded" and help teachers create classrooms that support student skills to develop scientific knowledge. To accomplish this, she pursues research projects that investigate ways that students and teachers can use self-regulated learning theory in science and engineering, as well as how inclusive STEM schools can help students succeed. During her tenure as a secondary teacher, she had a National Board Certification in Early Adolescent Science and was an Albert Einstein Distinguished Educator Fellow for NASA. As a researcher, Dr. Peters-Burton has published over 100 articles, books, book chapters, and curriculum books focused on STEM education and educational psychology. She received the Outstanding Science Teacher Educator of the Year award from ASTE in 2016 and a Teacher of Distinction Award and a Scholarly Achievement Award from George Mason University in 2012, and in 2010 she was named University Science Educator of the Year by the Virginia Association of Science Teachers.

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See *www.routledge.com/products/9781138804234* for more information about *STEM Road Map: A Framework for Integrated STEM Education.*

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PHYSICS IN MOTION MODULE OVERVIEW

Vanessa B. Morrison, Andrea R. Milner, Janet B. Walton, Carla C. Johnson, and Erin Peters-Burton

THEME: Cause and Effect

LEAD DISCIPLINE: Science

MODULE SUMMARY

This module uses roller coasters as an entry point for students to explore the physics of motion. Students work collaboratively to investigate concepts such as energy, gravity, friction, and speed. Students use the engineering design process (EDP) as they create and evaluate their own mini roller coasters in the classroom (adapted from Koehler, Bloom, and Milner, 2015).

ESTABLISHED GOALS AND OBJECTIVES

At the conclusion of this module, students will be able to do the following:

- Demonstrate awareness of concepts associated with motion, energy, gravity, force, push, pull, speed, inertia, direction, slope, and friction through play
- Use technology to gather research information and communicate
- Measure, compare, and evaluate numbers related to module concepts
- Demonstrate awareness of concepts associated with motion by discussing, investigating, and creating marble track roller coasters
- Identify careers associated with roller coaster design and construction
- Describe and apply the EDP
- Design, construct, test, and evaluate marble track roller coasters

CHALLENGE OR PROBLEM FOR STUDENTS TO SOLVE: ROLLER COASTER DESIGN CHALLENGE

Student teams are challenged to create a marble track roller coaster that meets specific design criteria. Students investigate, design, construct, test, and evaluate their tracks and decide on the best design.

CONTENT STANDARDS ADDRESSED IN THIS STEM ROAD MAP MODULE

A full listing with descriptions of the standards this module addresses can be found in Appendix C (p. 111). Listings of the particular standards addressed within lessons are provided in a table for each lesson in Chapter 4.

STEM RESEARCH NOTEBOOK

Each student should maintain a STEM Research Notebook, which will serve as a place for students to organize their work throughout this module (see p. 12 for more general discussion on setup and use of the notebook). All written work in the module should be included in the notebook, including records of students' thoughts and ideas, fictional accounts based on the concepts in the module, and records of student progress through the EDP. The notebooks may be maintained across subject areas, giving students the opportunity to see that although their classes may be separated during the school day, the knowledge they gain is connected. The lesson plans for this module contain STEM Research Notebook Entry sections (numbered 1–14), and templates for each notebook entry are included in Appendix A (p. 93).

Emphasize to students the importance of organizing all information in a Research Notebook. Explain to them that scientists and other researchers maintain detailed Research Notebooks in their work. These notebooks, which are crucial to researchers' work because they contain critical information and track the researchers' progress, are often considered legal documents for scientists who are pursuing patents or wish to provide proof of their discovery process.

MODULE LAUNCH

Launch the module by conducting an interactive read-aloud of *Energy in Motion,* by Melissa Stewart. Next, have students participate in a small movement investigation and then view the video "Sid the Science Kid: 'Sid's Super Kick,' part 2," found at *www.dailymotion.com/video/x15oaoe*.

PREREQUISITE SKILLS FOR THE MODULE

Students enter this module with a wide range of preexisting skills, information, and knowledge. Table 3.1 provides an overview of prerequisite skills and knowledge that students are expected to apply in this module, along with examples of how they apply this knowledge throughout the module. Differentiation strategies are also provided for students who may need additional support in acquiring or applying this knowledge.

Table 3.1. Prerequisite Key Knowledge and Examples of Applications and Differentiation Strategies

Prerequisite Key Knowledge	Application of Knowledge by Students	Differentiation for Students Needing Additional Support
Science • Understand cause and effect	*Science* • Determine how specific design elements of a marble track influence the marble's behavior on the track.	*Science* • Provide students with content via books, videos, songs, and computer programs to help students understand the motion of roller coasters and other objects affected by gravity. • Read aloud picture books to class, and have students identify cause and effect sequences.
Mathematics • Number sense	*Mathematics* • Use comparative measurements to make decisions to enhance the construction of marble tracks.	*Mathematics* • Provide examples of ways to measure observed phenomena such as distance, height, and time. • Model measurement techniques using standard and nonstandard units of measurement. • Read aloud nonfiction texts about measurement to class. • Provide opportunities for students to practice measurement in a variety of settings (e.g., in the classroom and outdoors).

Continued

Table 3.1. (*continued*)

Prerequisite Key Knowledge	Application of Knowledge by Students	Differentiation for Students Needing Additional Support
Language and Inquiry Skills • Visualize • Make predictions • Record ideas and observations using pictures and words • Ask and respond to questions	*Language and Inquiry Skills* • Make and confirm or reject predictions. • Share thought processes through notebooking, asking and responding to questions, and using the engineering design process.	*Language and Inquiry Skills* • As a class, make predictions when reading fictional texts. • As a class, make predictions about observed natural phenomena (e.g., gravity). • Model the process of using information and prior knowledge to make predictions. • Provide samples of notebook entries.
Speaking and Listening • Participate in group discussions	*Speaking and Listening* • Engage in collaborative group discussions in the development of the marble tracks.	*Speaking and Listening* • Model speaking and listening skills. • Create a class list of good listening and good speaking practices. • Read aloud picture books that feature collaboration and teamwork.

POTENTIAL STEM MISCONCEPTIONS

Students enter the classroom with a wide variety of prior knowledge and ideas, so it is important to be alert to misconceptions, or inappropriate understandings of foundational knowledge. These misconceptions can be classified as one of several types: "preconceived notions," opinions based on popular beliefs or understandings; "nonscientific beliefs," knowledge students have gained about science from sources outside the scientific community; "conceptual misunderstandings," incorrect conceptual models based on incomplete understanding of concepts; "vernacular misconceptions," misunderstandings of words based on their common use versus their scientific use; and "factual misconceptions," incorrect or imprecise knowledge learned in early life that remains unchallenged (NRC 1997, p. 28). Misconceptions must be addressed and dismantled for students to reconstruct their knowledge, and therefore teachers should be prepared to take the following steps:

- *Identify students' misconceptions.*
- *Provide a forum for students to confront their misconceptions.*
- *Help students reconstruct and internalize their knowledge, based on scientific models. (NRC 1997, p. 29)*

Keeley and Harrington (2010) recommend using diagnostic tools such as probes and formative assessment to identify and confront student misconceptions and begin the process of reconstructing student knowledge. Keeley's *Uncovering Student Ideas in Science* series contains probes targeted toward uncovering student misconceptions in a variety of areas and may be a useful resource for addressing student misconceptions in this module.

Some commonly held misconceptions specific to lesson content are provided with each lesson so that you can be alert for student misunderstanding of the science concepts presented and used during this module. The American Association for the Advancement of Science has also identified misconceptions that students frequently hold regarding various science concepts (see the links at *http://assessment.aaas.org/topics*).

SRL PROCESS COMPONENTS

Table 3.2 (p. 28) illustrates some of the activities in the Physics in Motion module and how they align with the self-regulated learning (SRL) process before, during, and after learning.

Table 3.2. SRL Process Components

Learning Process Components	Example From Physics in Motion Module	Lesson Number and Learning Component
BEFORE LEARNING		
Motivates students	Students perform fun activities such as hopping on one leg and waving their hands to investigate what they know about motion. Students also participate in an interactive read-aloud of the book *Energy in Motion.*	Lesson 1, Introductory Activity/Engagement
Evokes prior learning	Students demonstrate their own knowledge about motion and things that move through play in their STEM Research Notebooks.	Lesson 1, Introductory Activity/Engagement
DURING LEARNING		
Focuses on important features	Students use the engineering design process (EDP) to design virtual roller coasters. Students are guided through the process using the steps of the EDP by addressing specific questions in the lesson. Teachers track student responses to the EDP questions.	Lesson 2, Activity/ Exploration
Helps students monitor their progress	Students share their most successful virtual roller coaster designs with the class, by showing either their designs on the computer or their sketches of their best designs and explaining the designs.	Lesson 2, Activity/ Exploration
AFTER LEARNING		
Evaluates learning	Student teams share the marble track roller coasters they designed, built, tested, and improved in the lesson. The class discusses the physics concepts relevant to the success or failure of track designs.	Lesson 3, Explanation
Takes account of what worked and what did not work	Students design additional marble tracks incorporating what they learned from their own and other teams' designs.	Lesson 3, Elaboration/ Application of Knowledge

STRATEGIES FOR DIFFERENTIATING INSTRUCTION WITHIN THIS MODULE

For the purposes of this curriculum module, differentiated instruction is conceptualized as a way to tailor instruction—including process, content, and product—to various student needs in your class. A number of differentiation strategies are integrated into lessons across the module. The problem- and project-based learning approach used in the lessons is designed to address students' multiple intelligences by providing a variety of entry points and methods to investigate the key concepts in the module (e.g., investigating motion through play, through structured investigations, and through interactive read-alouds). Differentiation strategies for students needing support in prerequisite knowledge can be found in Table 3.1 (p. 25). You are encouraged to use information gained about student prior knowledge during introductory activities and discussions to inform your instructional differentiation. Strategies incorporated into this lesson include flexible grouping, varied environmental learning contexts, assessments, compacting, tiered assignments and scaffolding, and mentoring.

Flexible Grouping. Students work collaboratively in a variety of activities throughout this module. Grouping strategies you might employ include student-led grouping, grouping students according to ability level or common interests, grouping students randomly, or grouping them so that students in each group have complementary strengths (for instance, one student might be strong in mathematics, another in art, and another in writing).

Varied Environmental Learning Contexts. Students have the opportunity to learn in various contexts throughout the module, including alone, in groups, in quiet reading and research-oriented activities, and in active learning in inquiry and design activities. In addition, students learn in a variety of ways, including through doing inquiry activities, journaling, reading a variety of texts, watching videos, participating in class discussion, and conducting web-based research.

Assessments. Students are assessed in a variety of ways throughout the module, including individual and collaborative formative and summative assessments. Students have the opportunity to produce work via written text, oral and media presentations, and modeling.

Compacting. Based on student prior knowledge you may wish to adjust instructional activities for students who exhibit prior mastery of a learning objective. Since student work in science is largely collaborative throughout the module, this strategy may be most appropriate for mathematics, social studies, or ELA activities. You may wish to compile a classroom database of supplementary readings for a variety of reading levels and on a variety of topics related to the module's topic to provide opportunities for students to undertake independent reading.

Tiered Assignments and Scaffolding. Based on your awareness of student ability, understanding of concepts, and mastery of skills, you may wish to provide students with variations on activities by adding complexity to assignments or providing more or fewer learning supports for activities throughout the module. For instance, some students may need additional support in reading or may benefit from cloze sentence handouts to enhance vocabulary understanding. Other students may benefit from expanded reading selections and additional reflective writing or from working with manipulatives and other visual representations of mathematical concepts. You may also work with your school librarian to compile a set of topical resources at a variety of reading levels.

Mentoring. As group design teamwork becomes increasingly complex throughout the module, you may wish to have a resource teacher, older student, or volunteer work with groups that struggle to stay on-task and collaborate effectively.

STRATEGIES FOR ENGLISH LANGUAGE LEARNERS

Students who are developing proficiency in English language skills require additional supports to simultaneously learn academic content and the specialized language associated with specific content areas. WIDA (2012) has created a framework for providing support to these students and makes available rubrics and guidance on differentiating instructional materials for English language learners (ELLs). In particular, ELL students may benefit from additional sensory supports such as images, physical modeling, and graphic representations of module content, as well as interactive support through collaborative work. This module incorporates a variety of sensory supports and offers ongoing opportunities for ELL students to work collaboratively.

When differentiating instruction for ELL students, you should carefully consider the needs of these students as you introduce and use academic language in various language domains (listening, speaking, reading, and writing) throughout this module. To adequately differentiate instruction for ELL students, you should have an understanding of the proficiency level of each student. The following five overarching preK–5 WIDA learning standards are relevant to this module:

- Standard 1: Social and Instructional Language. Focus on social behavior in group work and class discussions, following directions, and information gathering.
- Standard 2: The Language of Language Arts. Tell a story or recount an experience with appropriate facts and relevant, descriptive details, speaking audibly in coherent sentences.
- Standard 3: The Language of Mathematics. Order three objects by length; compare the lengths of two objects indirectly by using a third object. Analyze text of word problems.
- Standard 4: The Language of Science. Focus on safety practices, energy sources, ecology and conservation, natural resources, and scientific inquiry.
- Standard 5: The Language of Social Studies. Focus on resources and products; needs of groups, societies, and cultures; and location of objects and places.

SAFETY CONSIDERATIONS FOR THE ACTIVITIES IN THIS MODULE

The safety precautions associated with each investigation are based in part on the use of the recommended materials and instructions, legal safety standards, and better professional safety practices. Selection of alternative materials or procedures for these investigations may jeopardize the level of safety and therefore is at the user's own risk. Remember that an investigation includes three parts: (1) setup, in which you prepare the materials for students to use; (2) the actual hands-on investigation, in which students use the materials and equipment; and (3) cleanup, in which you or the students clean the materials and put them away for later use. The safety procedures for each investigation apply to all three parts. For more general safety guidelines, see the Safety in STEM section in Chapter 2 (p. 18).

We also recommend that you go over the safety rules that are included as part of the safety acknowledgment form with your students before beginning the first investigation. Once you have gone over these rules with your students, have them sign the safety acknowledgment form. You should also send the form home with students for parents or guardians to read and sign to acknowledge that they understand the safety procedures that must be followed by their children. A sample elementary safety acknowledgment form can be found on the NSTA Safety Portal at *http://static.nsta.org/pdfs/SafetyAcknowledgmentForm-ElementarySchool.pdf*.

DESIRED OUTCOMES AND MONITORING SUCCESS

The desired outcome for this module is outlined in Table 3.3, along with suggested ways to gather evidence to monitor student success. For more specific details on desired outcomes, see the Established Goals and Objectives sections for the module and individual lessons.

Table 3.3. Desired Outcome and Evidence of Success in Achieving Identified Outcome

Desired Outcome	Evidence of Success	
	Performance Tasks	Other Measures
Students understand and can demonstrate concepts associated with the physics of motion. Students apply these concepts in their marble track designs.	• Student teams design, construct, test, and evaluate multiple styles of roller coaster tracks. • Students each maintain a STEM Research Notebook with responses to questions and observations.	Students are assessed using the Observation, STEM Research Notebook, and Participation Rubric.

ASSESSMENT PLAN OVERVIEW AND MAP

Table 3.4 provides an overview of the major group and individual *products* and *deliverables,* or things that student teams will produce in this module, that constitute the assessment for this module. See Table 3.5 for a full assessment map of formative and summative assessments in this module.

Table 3.4. Major Products and Deliverables in Lead Disciplines for Groups and Individuals

Lesson	Major Group Products and Deliverables	Major Individual Products and Deliverables
1	• Team participation in Physics in Motion Game Days • Team participation in Playground Pals	• STEM Research Notebook entries #1–8
2	• Team virtual roller coaster designs and presentations	• STEM Research Notebook entries #9–12
3	• Team marble track roller coaster designs and presentations	• STEM Research Notebook entries #13–14

Table 3.5. Assessment Map for Physics in Motion Module

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
1	STEM Research Notebook *entries*	Individual	Formative	• Predict how toys will move when students apply various forces. • Predict how the equipment and their bodies will move when they use playground equipment. • Observe how toys move when students apply various forces. • Observe how the equipment and their bodies move when they use playground equipment. • Compare and contrast the motion of toys and the motion of playground equipment and their bodies. • Identify the forces of push and pull.
1	Physics in Motion Game Days *activity*	Group	Formative	• Predict how toys will move when students apply various forces. • Observe how toys move when students apply various forces. • Identify the forces of push and pull. • Identify gravity as a force.
1	Playground Pals *activity*	Group	Formative	• Predict how the equipment and their bodies will move when they use playground equipment. • Observe how the equipment and their bodies move when they use playground equipment. • Compare and contrast the motion of toys and the motion of playground equipment and their bodies. • Identify the forces of push and pull. • Identify gravity as a force.
2	STEM Research Notebook *entries*	Individual	Formative	• Describe how a roller coaster works. • Identify what safety precautions might be important for roller coaster riders. • Use the engineering design process (EDP) to create and evaluate virtual roller coaster tracks. • Communicate and present findings about virtual roller coaster tracks.

Continued

Table 3.5. (*continued*)

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
2	Design Time! *activity*	Group	Formative	• Understand how a roller coaster works. • Identify and explain gravity as a force that works on roller coaster cars. • Communicate and present findings about virtual roller coaster tracks.
3	Roller Coaster Design Challenge *activity*	Group	Summative	• Use the EDP to create marble track roller coasters. • Communicate and present findings about their marble track roller coasters. • Use their understanding of safety to create safety guidelines for their roller coasters. • Use their understanding of roller coasters to create flyers about their roller coasters.

MODULE TIMELINE

Tables 3.6–3.10 (pp. 35–37) provide lesson timelines for each week of the module. These timelines are provided for general guidance only and are based on class times of approximately 30 minutes.

Table 3.6. STEM Road Map Module Schedule for Week One

Day 1	Day 2	Day 3	Day 4	Day 5
Lesson 1 *Let's Explore Motion Through Play!* • Launch the module and introduce challenge. • Introduce STEM Research Notebooks. • Introduce motion with a class discussion.	*Lesson 1* *Let's Explore Motion Through Play!* • Hold a class discussion about motion and things that move. • Conduct interactive read-aloud of *Give It a Push! Give It a Pull! A Look at Forces*, by Jennifer Boothroyd.	*Lesson 1* *Let's Explore Motion Through Play!* • Introduce motion of kicking as a way of pushing by showing "Sid the Science Kid: 'Sid's Super Kick,' part 2" video. • Discuss motion of kicking and record student learning.	*Lesson 1* *Let's Explore Motion Through Play!* • Conduct interactive read-aloud of *Energy in Motion*, by Melissa Stewart. • Start class vocabulary chart.	*Lesson 1* *Let's Explore Motion Through Play!* • Introduce Physics in Motion Game Days. • Introduce engineering as a career. • Create class list of good team habits *(optional)*.

Table 3.7. STEM Road Map Module Schedule for Week Two

Day 6	Day 7	Day 8	Day 9	Day 10
Lesson 1 *Let's Explore Motion Through Play!* • Prepare for Physics in Motion Game Days by making and recording predictions about motion.	*Lesson 1* *Let's Explore Motion Through Play!* • Have students make and record observations of Physics in Motion Game Days activity.	*Lesson 1* *Let's Explore Motion Through Play!* • Continue Physics in Motion Game Days activity by having students experiment with different heights of ramps.	*Lesson 1* *Let's Explore Motion Through Play!* • Conduct interactive read-aloud of *And Everyone Shouted, "Pull!" A First Look at Forces and Motion,* by Claire Llewellyn. • Continue Physics in Motion Game Days activity by comparing students' predictions and observations.	*Lesson 1* *Let's Explore Motion Through Play!* • Conclude Physics in Motion Game Days activity by having students offer explanations for their observations. • Conduct interactive read-aloud of *Gravity*, by Jason Chin. • Introduce measurement.

Table 3.8. STEM Road Map Module Schedule for Week Three

Day 11	Day 12	Day 13	Day 14	Day 15
Lesson 1 *Let's Explore Motion Through Play!* • Conduct interactive read-aloud of the poem "The Seesaw" from *Poems to Count On*, by Sandra Liatsos. • Introduce Playground Pals activity and have students make predictions.	*Lesson 1* *Let's Explore Motion Through Play!* • Conclude Playground Pals activity by having students make observations.	*Lesson 1* *Let's Explore Motion Through Play!* • Have students offer explanations for their Playground Pals activity observations. • Conduct a lesson assessment.	*Lesson 1* *Let's Explore Motion Through Play!* • Discuss safety guidelines for playgrounds. • Conduct interactive read-aloud of *I Can Be Safe: A First Look at Safety*, by Pat Thomas.	*Lesson 2* *Roller Coaster Fun!* • Hold a class discussion about roller coasters. • Show video of roller coaster. • Conduct interactive read-aloud of *Roller Coaster*, by Marla Frazee.

Table 3.9. STEM Road Map Module Schedule for Week Four

Day 16	Day 17	Day 18	Day 19	Day 20
Lesson 2 *Roller Coaster Fun!* • Introduce size and speed comparisons to describe roller coasters. • Introduce careers associated with roller coasters. • Conduct interactive read-aloud of *Archibald Frisby*, by Michael Chesworth.	*Lesson 2* *Roller Coaster Fun!* • Show video about students designing a roller coaster. • Introduce the engineering design process. • Introduce the Design Time! virtual roller coaster design activity.	*Lesson 2* *Roller Coaster Fun!* • Have student teams design their roller coasters for the Design Time! activity. • Have student teams present their designs.	*Lesson 2* *Roller Coaster Fun!* • Discuss students' observations of their virtual roller coasters. • Conduct interactive read-aloud of *Gravity in Action: Roller Coasters!* by Joan Newton.	*Lesson 2* *Roller Coaster Fun!* • Discuss roller coaster safety guidelines. • Hold a class discussion on environmental impacts of roller coasters. • Introduce concept of speed.

Table 3.10. STEM Road Map Module Schedule for Week Five

Day 21	Day 22	Day 23	Day 24	Day 25
Lesson 3 *Roller Coaster Design Challenge* • Hold a class discussion about the engineering design process. • Review the module challenge and materials. • Introduce requirements for teams' roller coasters.	*Lesson 3* *Roller Coaster Design Challenge* • Review science content in *Gravity in Action: Roller Coasters!* by Joan Newton. • Begin Roller Coaster Design Challenge (Define and Learn).	*Lesson 3* *Roller Coaster Design Challenge* • Continue Roller Coaster Design Challenge (Plan, Try, and Test). • Students create safety rules for their roller coasters.	*Lesson 3* *Roller Coaster Design Challenge* • Complete Roller Coaster Design Challenge (Decide). • Teams share roller coaster designs.	*Lesson 3* *Roller Coaster Design Challenge* • Students build additional marble tracks incorporating what they learned from their own and other teams' designs. • Teams create a plan for a roller coaster to be placed within a theme park. • Each student creates a flyer for the team's roller coaster.

RESOURCES

The media specialist can help teachers locate resources for students to view and read about roller coasters and related physics content. Special educators and reading specialists can help find supplemental sources for students needing extra support in reading and writing. Additional resources may be found online. Community resources for this module may include civil engineers and mechanical engineers.

REFERENCES

Keeley, P., and R. Harrington. 2010. *Uncovering student ideas in physical science, volume 1: 45 new force and motion assessment probes.* Arlington, VA: NSTA Press.

Koehler, C., M. A. Bloom, and A. R. Milner. 2015. The STEM Road Map for grades K–2. In *STEM Road Map: A framework for integrated STEM education*, ed. C. C. Johnson, E. E. Peters-Burton, and T. J. Moore, 41–67. New York: Routledge. *www.routledge.com/products/9781138804234*.

National Research Council (NRC). 1997. *Science teaching reconsidered: A handbook.* Washington, DC: National Academies Press.

WIDA. 2012. 2012 amplification of the English language development standards: Kindergarten–grade 12. *https://wida.wisc.edu/teach/standards/eld.*

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Grade K

STEM Road Map for Elementary School

Physics in Motion

What if you could challenge your kindergartners to create a mini roller coaster as an entry point to understanding the physics of motion? With this volume in the *STEM Road Map Curriculum Series,* you can!

Physics in Motion outlines a journey that will steer your students toward authentic problem solving while grounding them in integrated STEM disciplines. Like the other volumes in the series, this book is designed to meet the growing need to infuse real-world learning into K–12 classrooms.

This interdisciplinary module uses project- and problem-based learning to help young children explore cause and effect. It prompts students to create marble track roller coasters as they make discoveries about energy, gravity, friction, and speed. Students will draw on physical science, mathematics, engineering, and English language arts to do the following:

- Demonstrate awareness of motion- and energy-related concepts through play.
- Use technology to research and communicate information.
- Measure, compare, and test numbers related to their project.
- Discuss, investigate, and create a marble track roller coaster.
- Identify careers associated with roller coaster design and construction.
- Describe and apply the engineering design process.

The *STEM Road Map Curriculum Series* is anchored in the *Next Generation Science Standards,* the *Common Core State Standards,* and the Framework for 21st Century Learning. In-depth and flexible, *Physics in Motion* can be used as a whole unit or in part to meet the needs of districts, schools, and teachers who are charting a course toward an integrated STEM approach.

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