Freewheeling

A Sample Activity from Introducing Simple & Powered Machines

education

Introduction

LEGO® Education is pleased to bring you 'Introducing Simple & Powered Machines'.

Who is it for?

This material is designed for use with students in grades six through eight. Working in pairs, students of any academic background can build, investigate, and learn from the models and activities included in this curriculum pack.

Please refer to the Next Generation Science Standards (NGSS) and the Common Core State Standards grids in the 'Curriculum' section of this curriculum pack to see which activities match your current teaching program.

What is it for?

The 'Introducing Simple & Powered Machines' curriculum pack enables students to work as young scientists, engineers, and designers providing them with settings, tools and activities that promote engineering design, science and mathematics.

Using our curriculum pack students are encouraged to involve themselves in real world investigations and problem-solving. They make assumptions and predictions. They design and make models and then observe the behavior of these models; they reflect and re-design, and then record and present their findings.

The 'Introducing Simple & Powered Machines' curriculum pack enables
you to partially cover the following Crosscutting Concepts and overall Science and Engineering Practices, which have been set forth in the NGSS.

Science and Engineering Practices:
- Asking questions (for science) and defining problems (for engineering)
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations (for science) and designing solutions (for engineering)
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

Crosscutting Concepts:
- Patterns
- Cause and Effect (Mechanism and explanation)
- Scale, Proportion, and Quantity
- Systems and System Models
- Energy and Matter (Flows, cycles, and conservation)
- Structure and Function
- Stability and Change

What is in it?

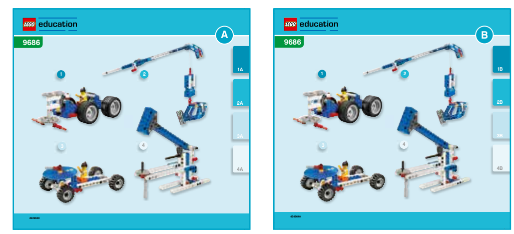
The 9686 Brick Set

The set has 396 elements, including a motor, and building instructions booklets for 14 activity models and for 37 principle models – all in full color. Some of the building instructions booklets are intended for use with other LEGO® Education curriculum packs.

Included is a sorting tray and accompanying element overview showing all the different elements in the building set. Everything is stored in a sturdy blue storage box with a transparent lid.

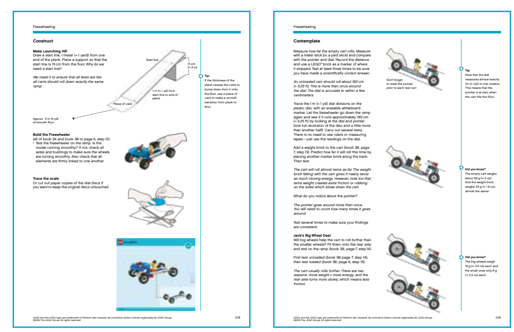
Building Instructions Booklets

For each of the activity models there are two building instructions, a booklet A and B. The building instructions are designed for two separate building processes, each building only half a model. By combining the two sub-assemblies, students work together to create a single, sophisticated and powerful model.



Teacher's Notes

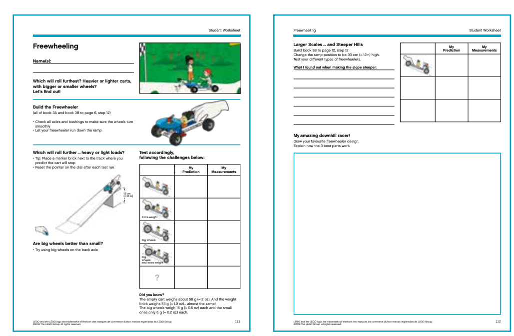
In the Teacher's Notes you will find all the information, tips and clues you need to set up a lesson. Each model the students build has specific key learning focus areas, vocabulary, questions, and answers, and further ideas for investigations.



Student Worksheets

Each student worksheet guides students to predict, try out, measure and record data, change the models to compare and contrast findings, and draw conclusions.

Let the students work in pairs, predict and test their predictions at least three times to be confident that their results are reliable. Then they record their main data accordingly. At the end of each activity, the students are challenged to design and draw a device that applies the major concepts they have just explored.



Assessments

Three different assessment materials are provided for all fourteen of the activities and the six problem-solving activities. These materials define clear learning goals before the students start each activity and motivate the students to challenge themselves throughout the learning process. You can also use these materials to assess your students' development in different learning areas.

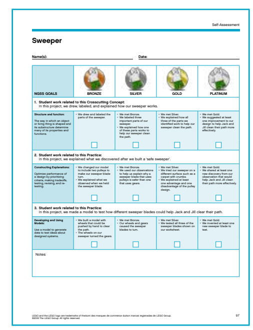
Student Worksheets

The student worksheets should be used record each student's work throughout each activity. These worksheets are an easy-to-use assessment tool that will give you a clear picture of each student's level and achievement during each activity. They can also comprise a valuable part of the students' log books.

Rubrics

1. Activity Assessment

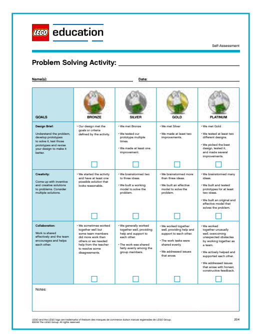
This rubric page can help students to evaluate their activity work according to learning goals based on two science-related NGSS Practices and one theme from the NGSS Crosscutting Concepts.



2. Problem-Solving Assessment

This rubric can help students to evaluate their problem-solving work according to the engineering-related learning goals from the NGSS and learning objectives that are prominent in both the Common Core State Standards and 21st century skill set, specifically:

- How well did their design meet the requirements of the design brief?
- How creative was their solution?
- How well did their team work together?



Each rubric includes four levels: Bronze, Silver, Gold, and Platinum. The intention of the rubrics is to help students reflect on what they have done well in relation to the learning goals and what they might have done better. Students can write comments or questions in the 'Notes' section of each rubric.

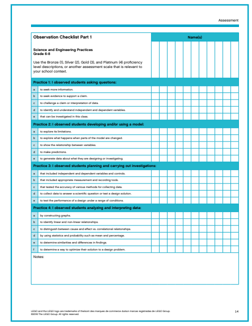
Students should mark the rubric. If you prefer to emphasize formative assessment, ask the students to set their learning goals before they start each activity and to record the dates that correspond to their completion of each level.

You can also use the rubrics as a tool in your own evaluation of your students' work by marking a grade in the appropriate column and writing optional comments in the 'Notes' section.

Observation Checklist
If a more science and engineering practices based approach to assessment is required in the problem-solving activities, you can use the Observation Checklist provided in the Teacher's Notes to record your students' grades.

You can either use the Bronze (1), Silver (2), Gold (3), and Platinum (4) proficiency level descriptions, or use other assessment criteria that are relevant to your school context.

Where can I find the assessment materials?
You can find the assessment materials in the Teacher's Notes for each of the activities and problem-solving activities.


Assessment

Observation Checklist Part 1 Science and Engineering Practices Grade 6-8 Use the Bronze (1), Silver (2), Gold (3), and Platinum (4) proficiency level descriptions, or another assessment scale that is relevant to your school context.		Name(s)
Practice 1: I observed students asking questions:		
a	to seek more information.	
b	to seek evidence to support a claim.	
c	to challenge a claim or interpretation of data.	
d	to identify and understand independent and dependent variables.	
e	that can be investigated in this class.	
Practice 2: I observed students developing and/or using a model:		
a	to explore its limitations.	
b	to explore what happens when parts of the model are changed.	
c	to show the relationship between variables.	
d	to make predictions.	
e	to generate data about what they are designing or investigating.	
Practice 3: I observed students planning and carrying out investigations:		
a	that included independent and dependent variables and controls.	
b	that included appropriate measurement and recording tools.	
c	that tested the accuracy of various methods for collecting data.	
d	to collect data to answer a scientific question or test a design solution.	
e	to test the performance of a design under a range of conditions.	
Practice 4: I observed students analyzing and interpreting data:		
a	by constructing graphs.	
b	to identify linear and non-linear relationships.	
c	to distinguish between cause and effect vs. correlational relationships.	
d	by using statistics and probability such as mean and percentage.	
e	to determine similarities and differences in findings.	
f	to determine a way to optimize their solution to a design problem.	

Notes:

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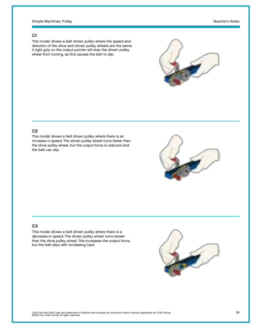
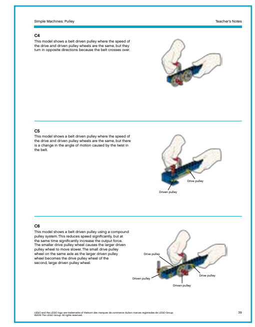
Three Levels of Progression

The 'Introducing with Simple and Powered Machines' curriculum pack consists of thirty-eight principle models, fourteen activities, and six problem-solving activities. Each of these three components represents one level of progression, and each is described in more detail below.

Principle Models

The principle models let students experience the mechanical and structural principles normally hidden away inside everyday machines and structures. The many easy-to-build models each present a hands-on demonstration of one of the concepts of simple machines, mechanisms and structures in a clear, straight-forward manner.

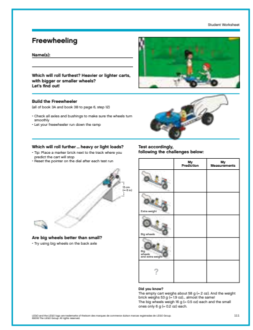
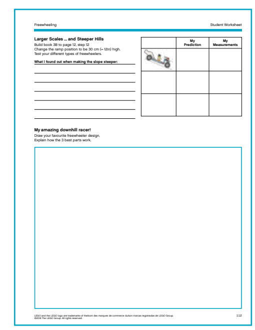
The principle models are a pathway for students to understand and integrate mechanical and structural principles applied in their own models.

Activities

The fourteen activities allow students to apply and develop their knowledge of science and engineering design. These activities create a positive learning environment and offer a complete scientific learning process in which students are able to make predictions, build models, run tests, record data, make comparisons, and improve their models in order to create a better solution.

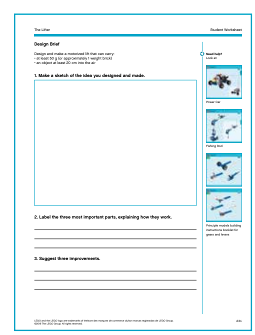
These fourteen activities connect with the concepts introduced by the principle models and help students to prepare for the increasingly difficult challenges they will meet in the problem-solving activities.

Problem-Solving Activities

The six problem-solving activities all feature real-life problems that can be solved in several ways. Students will be able to test and integrate more than just one principle at a time.

The problem descriptions and the closely-defined design briefs are provided in the student worksheets. Descriptions of learning focus areas, materials needed, extra challenges and how to progress can be found in the Teacher's Notes.

The Teacher's Notes for each challenge provide tips on what and how to measure while at the same time carrying out fair testing of the solutions.

As additional support we have included suggested solutions to the problems posed. Use these as 'tips and tricks', or print them and hang them as posters as inspiration for the students. The suggested problem-solving model solutions are only meant as guiding principles for any workable solution the students will come up with themselves.

Classroom Management Tips

For Your First LEGO® Education Activity, and Beyond

1. Before Class
- Open one of the LEGO® brick sets and sort the bricks by following the sorting suggestion on the back of the top card.
- Label the boxes so that you can recognize which box belongs to which student(s).
- Download the curriculum pack from the URL that is printed on the lid of each set.
- Try to complete the activity using the Student Worksheets.

2. During Class
- Let the students sort their LEGO brick sets at the beginning of the first lesson.
- Have the students use the lid of their set as a working tray.
- Use a jar to collect stray pieces.
- Make adjustments in order to challenge the students who are ready to improve and develop new skills.
- Allow time for students to use the self-assessment rubric when they are done with the activity.

3. After Class
- Plan to stop the lesson with enough time to allow the students to tidy up.
- If you did not finish the activity, store the LEGO sets and the models so that they are ready for the next lesson.
- Evaluate the lesson.
- Book a LEGO Education training session if you need further inspiration.

How much time do I need?
A 90-minute class period is ideal to be able to explore, build, and test in depth all the extension ideas built into the material and for the students to make any creative variations of their own.

How do I handle the building instructions booklets?
For easy classroom management we suggest storing the building instructions booklets in separate plastic folders in binders so that they are at hand and ready to use at the beginning of each lesson.

You can also ask your students to download the building instructions booklets from the URL that is printed on the lid of each set, and save them to their devices.

What's needed in my classroom?
Tables may be pushed aside to let models roll across a smooth floor. A desk fan may be needed to make a breeze, hair-dryers to make land yacht races, etc. Ideally, a computer or computers should be available for students to explore the Jack and Jill animated activity briefings.

Students need to be able to construct in pairs facing each other or side-by-side. It is also an advantage to have a cupboard or shelves to store the sets lying flat with any unfinished models on top of them.

LEGO® Education 4C Approach

The activities follow LEGO Education's 4C approach; Connect, Construct, Contemplate, and Continue. This enables you to progress naturally through the activities.

Connect

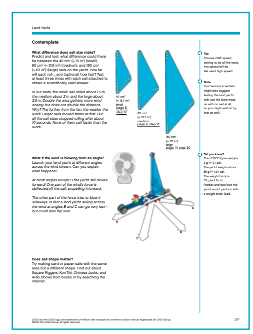
Creating a connection between a past and new learning experience stimulates the growth of new knowledge. Each activity therefore provides a short text with insights into the purpose and function of the specific model. The text is supported by a short video of a real-life machine similar to the LEGO® model. Use the text and video as a starting point for a class discussion or you could draw on your own experiences to provide an engaging introduction to the activity.

Construct

The construction of models engages both hands and minds. Using the building instructions, students build models embodying the concepts related to the key learning areas. Tips are provided for testing and ensuring each model functions as intended.

Contemplate

Contemplating is the opportunity to deepen the understanding of previous knowledge and new experiences. Based on scientific method, the activities encourage the students to discuss and reflect on their investigations, and adapt their ideas to the task at hand.



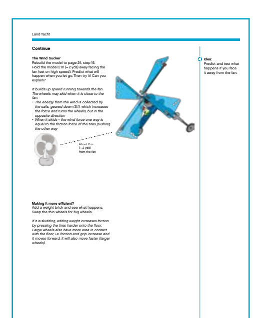
Each activity requires the students to predict an outcome, test, calculate and record their findings. We suggest encouraging the students to present their findings together with their explanations and rationales to each other.

We suggest stimulating the students' reflections on their investigations by having them consider patterns or trends in their findings, identify variables and describing advantages and disadvantages in model function and design.

This stage in the student's work process provides an opportunity for you to begin evaluating the learning outcome and progress of the individual student.

Continue

Learning is always more enjoyable and creative when it is adequately challenging. Maintaining this challenge and the pleasure of accomplishment naturally inspires the continuation of more advanced work. The open-ended continue activities challenge the students though a series of 'what if' questions to focus on particular features of the model that might be re-designed to give improved and optimized performance.



LEGO education

Curriculum Grid

Objective Number	NGSS Grade 6-8 ● = Fully covered ◐ = Partially covered	Activities: Sweeper	Fishing Rod	Freewheeling	The Hammer	Trundle Wheel	Letter Balance	Click-Clock	Windmill	Land Yacht	Flywheeler	Power Car	Dragster	The Walker	Dogbot	Problem-Solving Activities: Uphill Struggle	The Magic Lock	Stamping Letters	Beaten	The Lifter	The Bat
Disciplinary Core Ideas: Physical Science																					
1	MS-PS2 Motion and Stability: Forces and Interactions	◐	◐	●	◐	◐	◐	◐	◐	●	◐	●	◐	◐	◐	●	◐	◐	◐	●	◐
2	MS-PS3 Energy	◐	◐	◐	●	◐	◐	◐	●	◐	●	◐	●	◐	◐	◐	◐	◐	◐	◐	◐
Crosscutting Concepts																					
1	Patterns	◐	◐	◐	●	◐	◐	◐	◐	◐	◐	◐	◐	◐	●	◐	◐	●	●	◐	●
2	Cause and effect	◐	◐	◐	◐	◐	●	◐	◐	◐	●	◐	◐	◐	◐	●	●	●	●	●	●
3	Scale, proportion, and quantity	◐	◐	◐	◐	●	◐	●	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
4	Systems and system models	◐	●	◐	◐	◐	◐	◐	◐	◐	◐	◐	●	◐	◐	●	●	●	●	●	●
5	Energy and matter	◐	◐	◐	◐	◐	◐	◐	●	●	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
6	Structure and Function	●	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	●	◐	●	●	●	●	●	●
7	Stability and change	◐	◐	●	◐	◐	◐	◐	◐	◐	◐	●	◐	◐	◐	●	◐	◐	◐	●	◐
Science and Engineering Practices																					
1	Asking questions and Defining Problems	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	●	●	●	●	●	●
2	Developing and using models	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
3	Planning and carrying out investigations	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
4	Analyzing and interpreting data	◐	◐	◐	●	●	◐	◐	◐	◐	●	◐	◐	◐	◐	●	●	●	●	●	●
5	Using mathematics, Informational and Computer Technology, and computational thinking	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	●	●	●	●	●	●
6	Constructing explanations and designing solutions	●	◐	●	●	●	◐	◐	◐	◐	◐	◐	●	●	◐	●	●	●	●	●	●
7	Engaging in argument from evidence	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	●	●	●	●	●	●
8	Obtaining, evaluating, and communicating information	◐	◐	◐	◐	◐	◐	●	●	●	◐	●	◐	●	◐	●	●	●	●	●	●

Common Core Mathematics Standards Grade 6-8

● = Fully covered
◐ = Partially covered

Objective Number	Common Core Mathematics Standards Grade 6-8	Activities														Problem-Solving Activities					
		Sweeper	Fishing Rod	Freewheeling	The Hammer	Trundle Wheel	Letter Balance	Click-Clock	Windmill	Land Yacht	Flywheeler	Power Car	Dragster	The Walker	Dogbot	Uphill Struggle	The Magic Lock	Stamping Letters	Beaten	The Lifter	The Bat
Mathematical Practice																					
MP1	Make sense of problems and persevere in solving them	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
MP2	Reason abstractly and quantitatively	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
MP3	Construct viable arguments and critique the reasoning of others	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
MP4	Model with mathematics	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
MP5	Use appropriate tools strategically	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
MP6	Attend to precision	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
MP7	Look for and make use of structure	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
MP8	Look for and express regularity in repeated reasoning	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
Ratios & Proportional Relationships																					
6.RP.A	Understand ratio concepts and use ratio reasoning to solve problems	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
7.RP.A	Analyze proportional relationships and use them to solve real-world and mathematical problems	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
The Number System																					
6.NS.B	Compute fluently with multi-digit numbers and find common factors and multiples	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
6.NS.C	Apply and extend previous understandings of numbers to the system of rational numbers	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
7.NS.A	Apply and extend previous understandings of operations with fractions	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
Expressions & Equations																					
6.EE.A	Apply and extend previous understandings of arithmetic to algebraic expressions	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
6.EE.B	Reason about and solve one-variable equations and inequalities	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
6.EE.C	Represent and analyze quantitative relationships between dependent and independent variables	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
7.EE.A	Use properties of operations to generate equivalent expressions	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
7.EE.B	Solve real-life and mathematical problems using numerical and algebraic expressions and equations	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
8.EE.B	Understand the connections between proportional relationships, lines, and linear equations	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
8.EE.C	Analyze and solve linear equations and pairs of simultaneous linear equations	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
Geometry																					
6.G.A	Solve real-world and mathematical problems involving area, surface area, and volume			◐						◐	◐	◐	◐								
7.G.A	Draw, construct, and describe geometrical figures and describe the relationships between them	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
7.G.B	Solve real-life and mathematical problems involving angle measure, area, surface area, and volume	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
Function																					
8.F.A	Define, evaluate, and compare functions	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
8.F.B	Use functions to model relationships between quantities	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Statistics & Probability																					
6.SP.A	Develop understanding of statistical variability	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
6.SP.B	Summarize and describe distributions	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
8.SP.A	Investigate patterns of association in bivariate data	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐

Common Core English Language Arts Grade 6-8

● = Fully covered
◐ = Partially covered

Objective Number	Common Core English Language Arts Grade 6-8	Activities														Problem-Solving Activities					
		Sweeper	Fishing Rod	Freewheeling	The Hammer	Trundle Wheel	Letter Balance	Click-Clock	Windmill	Land Yacht	Flywheeler	Power Car	Dragster	The Walker	Dogbot	Uphill Struggle	The Magic Lock	Stamping Letters	Beaten	The Lifter	The Bat
Speaking and Listening																					
SL 6.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
SL 6.2	Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
SL 6.3	Delineate a speaker's argument and specific claims, distinguishing claims that are supported by reasons and evidence from claims that are not	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
SL 6.4	Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
SL 6.5	Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
SL 6.6	Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate. (See grade 6 Language standards 1 and 3 for specific expectations.)	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
SL 7.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
SL 7.2	Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
SL 7.3	Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and the relevance and sufficiency of the evidence	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
SL 7.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
SL 7.5	Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
SL 7.6	Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate. (See grade 7 Language standards 1 and 3 here for specific expectations.)	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
SL 8.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
SL 8.2	Analyze the purpose of information presented in diverse media and formats (e.g., visually, quantitatively, orally) and evaluate the motives (e.g., social, commercial, political) behind its presentation	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
SL 8.3	Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
SL 8.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
SL 8.5	Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
SL 8.6	Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate. (See grade 8 Language standards 1 and 3 here for specific expectations.)	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐

Objective Number	Common Core English Language Arts Grade 6-8 ● = Fully covered ◐ = Partially covered	Activities														Problem-Solving Activities					
		Sweeper	Fishing Rod	Freewheeling	The Hammer	Trundle Wheel	Letter Balance	Click-Clock	Windmill	Land Yacht	Flywheeler	Power Car	Dragster	The Walker	Dogbot	Uphill Struggle	The Magic Lock	Stamping Letters	Beaten	The Lifter	The Bat
Reading Standards for Literacy in Science and Technical																					
RST 6-8.1	Cite specific textual evidence to support analysis of science and technical texts	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
RST 6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
RST 6-8.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
RST 6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
RST 6-8.8	Distinguish among facts, reasoned judgment based on research findings, and speculation in a text	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
RST 6-8.9	Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
Writing Standards for Literacy in History/Social Studies, Science, & Technical Subjects																					
WHST 6-8.1	Write arguments focused on discipline-specific content	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
WHST 6-8.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
WHST 6-8.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
WHST 6-8.5	With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
WHST 6-8.6	Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
WHST 6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
WHST 6-8.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
WHST 6-8.9	Draw evidence from informational texts to support analysis, reflection, and research	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
WHST 6-8.10	Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐

Freewheeling

Technology
- Using mechanisms – wheels and axles
- Assembling components

Science
- Measuring distance
- Reading and calibrating scales
- Forces
- Moving energy
- Energy of position
- Friction and air resistance
- Scientific investigation

Vocabulary
- Mass
- Position
- Friction
- Efficiency
- Kinetic energy
- Potenial energy

Other Materials Required
- 4 meters (≈ 4 yards) of smooth floor
- Masking tape
- Meter stick (yard stick) or measuring tape
- Plank of wood or shelf at least 1 meter (≈ 1 yard) long
- Pile of books or boxes to elevate the plank
- Spare LEGO® bricks for taking measurements
- Whiteboard marker
- Scissors

Connect

Jack and Jill are arguing as usual. They are making carts to see which one can roll the furthest down Launching Hill in their local Greenall Park.

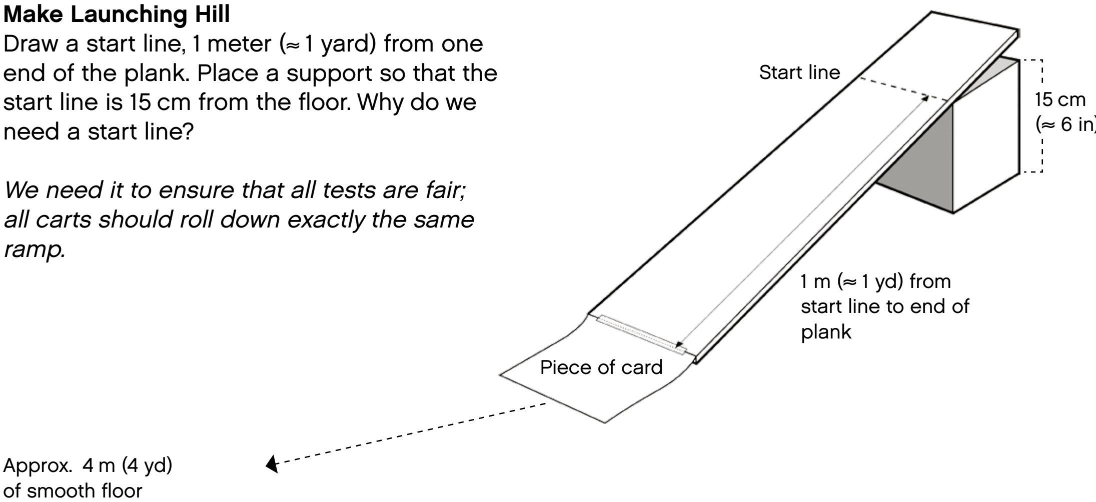
Jill says that if she puts some extra weight (Zog the Dog) on her cart, she will roll further because the cart is heavier. Jack thinks that because heavy loads are hard to move, he will go further. He prefers to go for bigger wheels, but Jill is not so sure this approach will help.

Which will roll further? Heavier or lighter carts, with bigger or smaller wheels?
Let's find out!

Construct

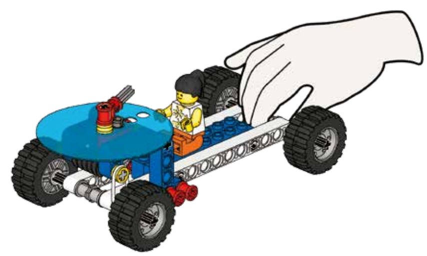
Make Launching Hill
Draw a start line, 1 meter (≈ 1 yard) from one end of the plank. Place a support so that the start line is 15 cm from the floor. Why do we need a start line?

We need it to ensure that all tests are fair; all carts should roll down exactly the same ramp.

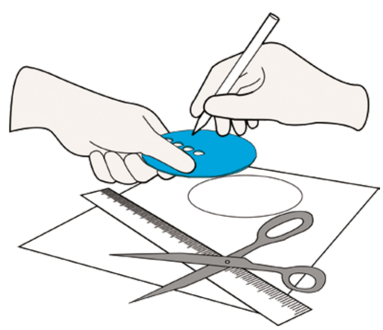


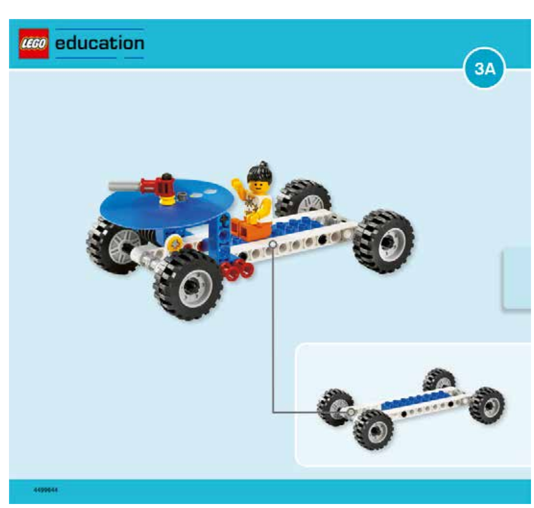
Tip:
If the thickness of the plank causes the carts to bump down from it onto the floor, use a piece of card to make a smooth transition from plank to floor.

Build the Freewheeler
(all of book 3A and book 3B to page 6, step 12)
- Test the freewheeler on the ramp. Is the model running smoothly? If not, check all axles and bushings to make sure the wheels are turning smoothly. Also check that all elements are firmly linked to one another



Trace the scale
Or cut out paper copies of the dial discs if you want to keep the original discs untouched.

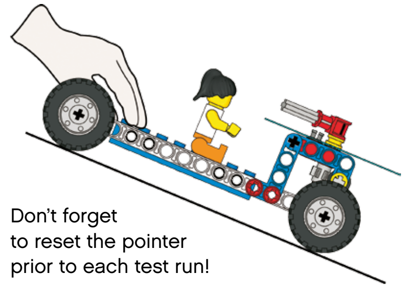




Contemplate

Measure how far the empty cart rolls. Measure with a meter stick (or a yard stick) and compare with the pointer and dial. Record the distance and use a LEGO® brick as a marker of where it stopped. Test at least three times to be sure you have made a scientifically correct answer.

An unloaded cart should roll about 160 cm (≈ 5.25 ft). This is more than once around the dial. The dial is accurate to within a few centimeters.

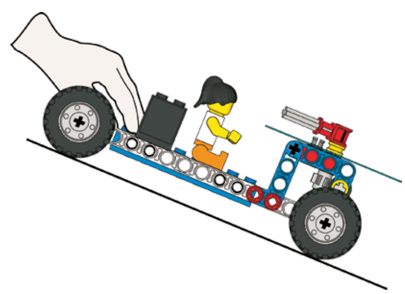


Don't forget to reset the pointer prior to each test run!

Tip:
Note that the dial measures almost exactly 1m (≈ 1yd) in one rotation. This means that the pointer is at zero when the cart hits the floor.

Trace the 1 m (≈ 1 yd) dial divisions on the plastic disc with an erasable whiteboard marker. Let the freewheeler go down the ramp again and see if it runs approximately 160 cm (≈ 5.25 ft) by looking at the dial and pointer (one full revolution of the disc and a little more than another half). Carry out several tests. There is no need to use rulers or measuring tapes – just use the readings on the dial.

Add a weight brick to the cart (book 3B, page 7, step 13). Predict how far it will roll this time by placing another marker brick along the track. Then test.



The cart will roll almost twice as far. The weight brick 'falling' with the cart gives it nearly twice as much moving energy. However, note too that extra weight creates extra friction or rubbing on the axles which slows down the cart.

Did you know?
The empty cart weighs about 58 g (≈ 2 oz). And the weight brick weighs 53 g (≈ 1.9 oz)... almost the same!

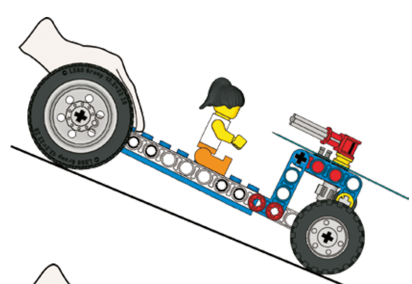
What do you notice about the pointer?

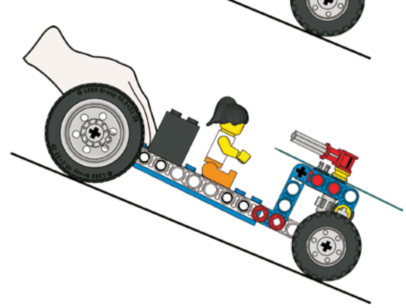
The pointer goes around more than once. You will need to count how many times it goes around.

Test several times to make sure your findings are consistent.

Jack's Big Wheel Deal
Will big wheels help the cart to roll further than the smaller wheels? Fit them onto the rear axle and test on the ramp (book 3B, page 7, step 14).

First test unloaded (book 3B page 7, step 14), then test loaded (book 3B, page 8, step 15).





The cart usually rolls further. There are two reasons: more weight = more energy, and the rear axle turns more slowly, which means less friction.

Did you know?
The big wheels weigh 16 g (≈ 0.5 oz) each and the small ones only 6 g (≈ 0.2 oz) each.

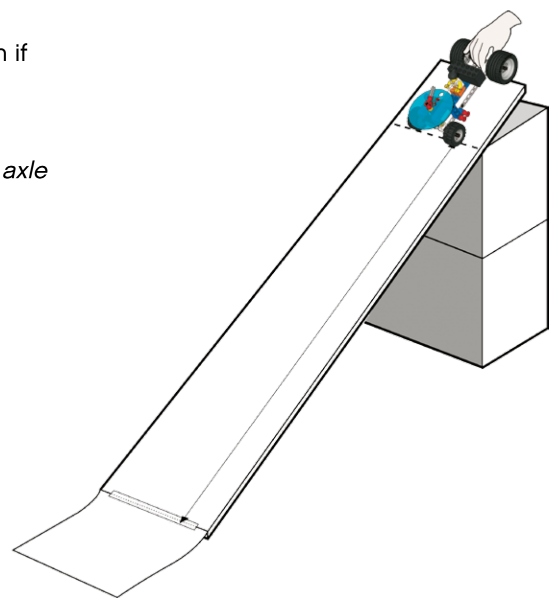
Continue

Super Scale
Build book 3B to page 12, step 12.
Replace the 8-tooth gear wheel with the 24 tooth gear. Predict and then test how far the cart will roll before the pointer completes one revolution.

It rolls 3 meters (≈ 3 yards). The new gear wheel has 3 times as many teeth as the small one. The worm gear has to turn 3 times as often to get the 24-tooth gear wheel to turn once. Now you will need to calibrate the scale to measure distances accurately to 3 meters (≈ 3 yards).

Super Slope
Predict first and then test what will happen if you double the height of the hill.

You double the potential energy, double the moving energy, but do not double the axle friction.



Observation Checklist Part 1

Science and Engineering Practices
Grade 6-8

Use the Bronze (1), Silver (2), Gold (3), and Platinum (4) proficiency level descriptions, or another assessment scale that is relevant to your school context.

		Name(s)										
Practice 1: I observed students asking questions:												
a	to seek more information.											
b	to seek evidence to support a claim.											
c	to challenge a claim or interpretation of data.											
d	to identify and understand independent and dependent variables.											
e	that can be investigated in this class.											
Practice 2: I observed students developing and/or using a model:												
a	to explore its limitations.											
b	to explore what happens when parts of the model are changed.											
c	to show the relationship between variables.											
d	to make predictions.											
e	to generate data about what they are designing or investigating.											
Practice 3: I observed students planning and carrying out investigations:												
a	that included independent and dependent variables and controls.											
b	that included appropriate measurement and recording tools.											
c	that tested the accuracy of various methods for collecting data.											
d	to collect data to answer a scientific question or test a design solution.											
e	to test the performance of a design under a range of conditions.											
Practice 4: I observed students analyzing and interpreting data:												
a	by constructing graphs.											
b	to identify linear and non-linear relationships.											
c	to distinguish between cause and effect vs. correlational relationships.											
d	by using statistics and probability such as mean and percentage.											
e	to determine similarities and differences in findings.											
f	to determine a way to optimize their solution to a design problem.											

Notes:

Observation Checklist Part 2 **Science and Engineering Practices** **Grade 6-8** Use the Bronze (1), Silver (2), Gold (3), and Platinum (4) proficiency level descriptions, or another assessment scale that is relevant to your school context.		Name(s)										
Practice 5: I observed students using mathematics and computational thinking:												
a	by including mathematical representations in their explanations and design solutions.											
b	by using an algorithm to solve a problem.											
c	by using concepts such as ratio, rate, percent, basic operations, or simple algebra.											
Practice 6: I observed students constructing explanations and design solutions:												
a	that included quantitative and qualitative relationships.											
b	that are based on scientific ideas, laws, and theories.											
c	that connect scientific ideas, laws, and theories to their own observations.											
d	that apply scientific ideas, laws, and theories.											
e	to help optimize design ideas while making trade-offs and revisions.											
Practice 7: I observed students engaging in arguments from evidence:												
a	that compare and critique two arguments on the same topic.											
b	while respectfully providing and receiving critiques using appropriate evidence.											
c	while presenting oral or written statements supported by evidence.											
d	while evaluating different design solutions based on agreed-upon criteria and constraints.											
Practice 8: I observed students evaluating and communicating information:												
a	when they read scientific text adapted for the classroom.											
b	when they read or wrote information in combinations of text, graphs, diagrams, and other media.											
c	when they created presentations about their investigations and/or design solutions.											
Notes:												

Freewheeling

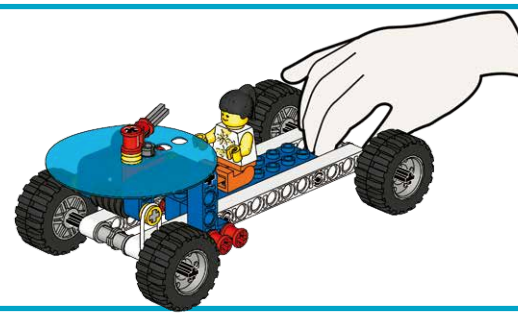
Name(s): ____________________

____

**Which will roll furthest? Heavier or lighter carts, with bigger or smaller wheels?
Let's find out!**

Build the Freewheeler

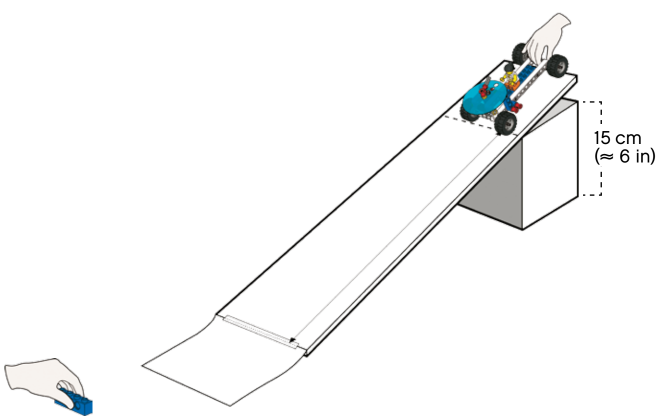
(all of book 3A and book 3B to page 6, step 12)



- Check all axles and bushings to make sure the wheels turn smoothly
- Let your freewheeler run down the ramp

Which will roll further ... heavy or light loads?

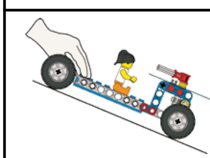
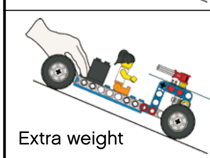
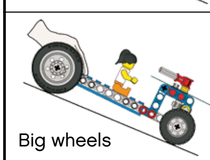
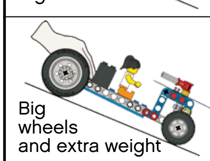
- Tip: Place a marker brick next to the track where you predict the cart will stop
- Reset the pointer on the dial after each test run



Are big wheels better than small?

- Try using big wheels on the back axle

Test accordingly, following the challenges below:

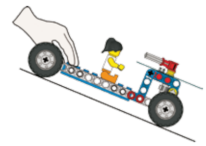
	My Prediction	My Measurements
		
 Extra weight		
 Big wheels		
 Big wheels and extra weight		
?		

Did you know?
The empty cart weighs about 58 g (≈ 2 oz). And the weight brick weighs 53 g (≈ 1.9 oz)... almost the same!
The big wheels weigh 16 g (≈ 0.5 oz) each and the small ones only 6 g (≈ 0.2 oz) each.

Larger Scales ... and Steeper Hills

Build book 3B to page 12, step 12
Change the ramp position to be 30 cm (≈ 12in) high.
Test your different types of freewheelers.

What I found out when making the slope steeper:

	My Prediction	My Measurements
		

My amazing downhill racer!

Draw your favourite freewheeler design.
Explain how the 3 best parts work.

Freewheeling

Name(s): ______________________ **Date:** ______________________

NGSS GOALS	 BRONZE	 SILVER	 GOLD	 PLATINUM
1. Student work related to this Crosscutting Concept: In this project, we tested what would change the motion of our car at the most — weight, wheel size, or steepness of the hill.				
Stability and Change: Explanations of stability and change in designed systems can be constructed by examining the forces at different scales..	• We predicted and measured how weight would affect the distance our car traveled. ☐	• We met Bronze. • We predicted and measured how wheel size would affect the distance our car traveled. ☐	• We met Silver. • We predicted and measured how the steepness of our hill affected distance our car traveled. ☐	• We met Gold. • We proposed a new experiment to explore other forces that affect the distance our car travels. ☐
2. Student work related to this Practice: In this project, we wrote a summary about what happened the motion of our car when we made the hill steeper.				
Analyzing and Interpreting Data: Identify independent and dependent variables and controls, how measurements will be recorded, and how many data are needed to support a claim.	• We identified which was the independent and which was the dependent variable when we did the hill steepness experiment. ☐	• We met Bronze. • We identified what parts of our experiment we needed to keep constant (i.e. as 'controls') for each trial we did. • We explained what we found out about the motion of our car when the hill got steeper. ☐	• We met Silver • We collected data for at least three trials for every variable we tested. • We used our data to support the ideas we described in our summary. ☐	• We met Gold • We proposed additional experiments to help us better answer our questions and understand more about how steepness affects our car's motion. ☐
3. Student work related to this Practice: In this project, we drew our favorite freewheeler design and explained how some parts of our car worked.				
Constructing Explanations: Apply scientific ideas or principles to design an object, tool, process or system.	• We drew our freewheeler. • We used the word 'force' in our explanation. ☐	• We met Bronze. • We used the word 'mass' or 'weight' when describing how parts of our car worked. ☐	• We met Silver. • We used the word 'friction' when describing how parts of our car worked. ☐	• We met Gold. • We connected at least two of these scientific terms to show how these ideas relate to each other and to our car. ☐

Notes:

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