

Name: _____

Pushing Pairs Data Sheet

Prediction

Item Pairs	1 st to Start	1 st to Stop
• Golf Ball • Ping Pong Ball		
• Baseball • Tennis Ball		
• Glass marble • Plastic marble		
• Glass marble • Ball Bearing		

Observations

Item Pairs	1 st to Start	1 st to Stop
• Golf Ball • Ping Pong Ball		
• Baseball • Tennis Ball		
• Glass marble • Plastic marble		
• Glass marble • Ball Bearing		

Connecting to the Next Generation Science Standards

3-5-ETS1 <https://www.nextgenscience.org/dci-arrangement/3-5-ets1-engineering-design>

The materials and activities in this article are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required.

Performance Expectation	Connections to Classroom Activity
3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	Students will: - Analyze various roller coaster systems containing faulty designs and make suggestions for improvement. - Modify and test roller coaster systems to determine how to improve the model.
Science and Engineering Practices	
Construct Explanations and Design Solutions Construct explanations that specify variables that describe and predict phenomena and in designing multiples solutions. Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem (3-5-ETS1-2)	Students will: - Reference Newton’s Laws of Motion to analyze and explain faulty roller coaster systems. - Share and explain multiple ways to improve faulty roller coaster systems with partners, in small groups, and during whole class discussions. - Work collaboratively to modify and test faulty systems.
Disciplinary Core Ideas	
5-PS2 Motion and Stability: Forces and Interactions Students who demonstrate understanding can support an argument that the gravitational force exerted by Earth on objects is directed down. 5- (PS2-1) ETS1-C: Optimizing the Design Solution Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (ETS1-3)	Students will: - Design and test a roller coaster system based upon Newton’s Laws of Motion. - Determine how to improve the model. - Modify and test the model.
Crosscutting Concept	
Energy and Matter Tracking energy and matter flows, into, out of, and within systems helps one understand their system’s behavior.	Students will: - Analyze various roller coaster systems containing faulty designs and make suggestions for improvement. - Design and test a roller coaster system based upon Newton’s Laws of Motion. - Determine how to improve the model.

	● Modify and test.
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Connecting to the Common Core State Standards

Common Core State Standard Connections	Connections to Classroom Activity
CCSS.ELA-LITERACY.SL.5.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on <i>grade 5 topics and texts</i> , building on others' ideas and expressing their own clearly.	● Students communicate the results and conclusions of their investigation within small and whole group discussions.

Coin Slide Student Handout

Name: _____

Newton's Third Law of Motion

Newton's Third Law (Law of Conservation of Momentum): For every action, there is an equal and opposite reaction.

Problem: We want to test the concepts of Newton's Third Law using our best observation skills. We will create an action force on a penny and observe the reaction force on other pennies.

Your Hypothesis: _____

Materials:

-8 pennies, 2 rulers, tape

Procedure:

1. Arrange the rulers and pennies on desktop as you see in the picture. The last penny in the group of 5 must be 1 inch away from the end of the rulers.



- 2.
3. You will repeat this setup to flick 2 pennies at the 5.



- 4.
5. And one more time, repeat the process to flick 3 pennies at the 5.



- 6.

Experiment:

You will conduct the experiment 3 successful times for each setup. The task is to flick the smaller group of pennies towards the larger group. You will then make observations about the reaction force the 5 pennies. You will also need to make observations about the action for pennies (groups of 1, 2, 3).

Data: Draw your observations in the space below.

-----1 Penny-----

Test 1-1.



Test 2-1.



Test 3-1.



Conclusion: Summarize what you observed about the reaction of the pennies at the end of each successful test.

-----2 Pennies-----

Test 1-2.



Test 2-2.



Test 3-2.



Conclusion: Summarize what you observed about the reaction of the pennies at the end of each successful test.

-----3 Pennies-----

Test 1-3.



Test 2-3.



Test 3-3.



Conclusion: Summarize what you observed about the reaction of the pennies at the end of each successful test.

Closing: What is Newton's Third Law of Motion?

Gravity Student Handout

Name: _____

Science: Gravity

PREDICTIONS: Falling Objects

Item	Fall Description (fast/medium/slow)	Defend your thinking
Tissue		
Wadded Tissue		
Rock		
Tennis Ball		
Baseball		
Ping Pong Ball		
Golf Ball		
Basketball		
Bowling Ball		

PART 1: Falling Objects

Item	Fall Description (fast/medium/slow)	Defend your thinking
Tissue		
Wadded Tissue		
Rock		
Tennis Ball		
Baseball		

Ping Pong Ball		
Golf Ball		
Basketball		
Bowling Ball		

Summarize your initial thinking for each object here. Did you defend your thinking with a single thought, meaning what did you base your decision on most or all of the time?

If you changed your mind and are having difficulties deciding on what to base your thinking off of, explain those thoughts here.

PART 2: Falling Pairs

Item	First to Floor	Defend your thinking
- Tissue - Rock		
- Wadded Tissue - Rock		
- Sheet of Paper - Paper Cube (same size of sheet)		
- Paper Cube - Rubber Cube (Toy)		
- Rubber Cube - Wood Cube		

• Tennis Ball • Baseball		
• Ping Pong Ball • Golf Ball		
• Basketball • Bowling Ball		
• Basketball • Tennis Ball		
• Bowling Ball • Golf Ball		

Summarize your initial thinking for each object here. Did you defend your thinking with a single thought, meaning what did you base your decision on most or all of the time?

If you changed your mind and are having difficulties deciding on what to base your thinking off of, explain those thoughts here.

Part 3: Falling Pairs (TEST)

Item	First to Floor	Correct? Yes, Continue. No, Stop/Talk/Write
• Tissue • Rock		
• Wadded Tissue • Rock		
• Sheet of Paper • Paper Cube (made from same size of sheet of paper)		
• Paper Cube • Rubber Cube (Toy)		

• Rubber Cube • Wood Cube		
• Tennis Ball • Baseball		
• Ping Pong Ball • Golf Ball		
• Basketball • Bowling Ball		
• Basketball • Tennis Ball		
• Bowling Ball • Golf Ball		

Gravity Closure

Some objects fall differently. What did our group conclude about why those objects fell differently from others?

Was your thinking supported today? Explain.

Was your thinking redirected today? Explain.

Summarize and define *gravity* in your own words supported by what you learned today.

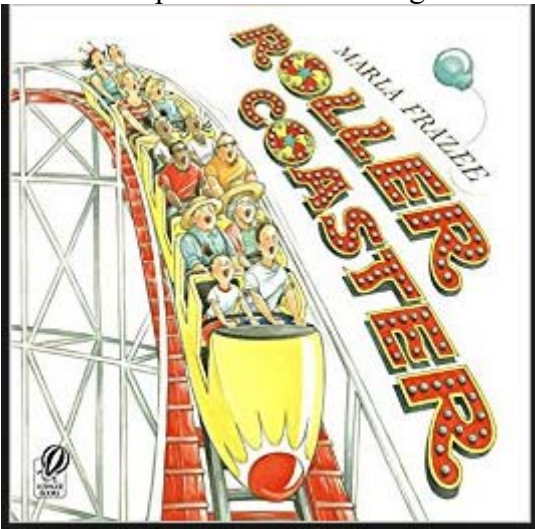
Rubric Used to Assess Performance and Application of Scientific Laws and Principles during the Small Group Rollercoaster Challenge.

Rollercoaster Elements	Evidence		Points 3 each	Comments
Vocabulary	Orally Explained	Labeled with Sticky Note	Points Earned	
Acceleration				
Centripetal Force				
Inertia				
Kinetic Energy				
Momentum				
Newton's 1 st Law				
Newton's 2 nd Law				
Newton's 3 rd Law				
Speed				
Potential Energy				
Velocity				
Points Earned			/33	

Design	Evidence	Points 3 each	Comments
Stable Structure			
Straights			
Loop(s)			
Curves			
Tunnel(s)			
Marble travels through all parts			
Marble stays on track			
Points Earned		/21	

Vocabulary /33	Design /21	Total Points Earned /54
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Roller Coaster Enrichment and Extension Ideas

Prior to the roller coaster challenge.	● Conduct investigations with Class 1, 2, and 3 levers. ● Use single and compound pulley systems to develop a deeper understanding of simple machines and forces. ● Use a ballistic car to demonstrate the arc and motion. The Ballistic Car demonstrates that the horizontal motion of an object is unaffected by forces which act solely in the vertical direction.  Source: WWW.ARBORSCI.COM ● https://www.youtube.com/watch?v=twUeBv7g1jI
Before and during the roller coaster challenge.	Before: Share Marla Frazee's children's book, <i>Roller Coaster</i>. Students share their experiences with riding a roller coaster.  Source: Frazee, M. (2003). <i>Roller Coaster</i>. Harcourt. During: Students test ways to change the speed and direction of a rolling object by building roller coasters out of pipe insulation. Source: Ansberry, K.R., and E.R. Morgan (2007). <i>More picture-perfect science lessons: Using children's books to guide inquiry, K-4</i>, 133-146. Arlington, VA: National Science Teacher Association.
During or after the roller coaster challenge.	The roller coaster design for Newton's 2nd Law uses a race track concept. Parallel tracks are designed and the plastic,

	glass, and bearing are compared to each other as they travel through the system. This system does not have any problems, it is designed for students to see how objects with different mass travel through a system, each part effecting something with mass slightly differently. The students can hypothesize which object will travel through quicker/finish first during the race. You may also preselect areas of the course to discuss with the students to make predictions about object behavior.
During or after the roller coaster challenge.	A poorly built roller coaster is used to demonstrate how as the marble moves through it loses energy in the turns, straights, and curves. The students observe how the design process must support Newton's 3rd Law by limiting the action and reaction forces to maintain the movement of the marble and limit movement within and of the structural system. Students draw the current design, then group up to develop ideas that would enhance the strength of the structure to allow for better motion of the marble and less action/reaction forces in the structural system.
After the roller coaster challenge.	Insurance Institute for Highway Safety videos. http://www.iihs.org/iihs/videos These videos provide students with another opportunity to see how the laws of physics work in car scenarios. I have found students have a higher appreciation for the whys of riding in cars, wearing seatbelts, sitting in the back seat, and children using car seats.
Before, during, or after the roller coaster challenge.	PhET interactive simulations allow students to manipulate and explore variables as they discover and learn about motion. • https://phet.colorado.edu/en/simulation/projectile-motion • https://phet.colorado.edu/en/simulation/energy-skate-park-basics • https://phet.colorado.edu/en/simulation/legacy/forces-and-motion • https://phet.colorado.edu/en/simulation/gravity-force-lab