Professor: Dr. Allison Downing
Lesson: Roller Coasters
Grade: 2, 3, 5
*Adapted from Ansberry, K. R., & Morgan, E. R. (2010). *Picture-perfect Science Lessons, Expanded 2nd Edition : Using Children's Books to Guide Inquiry, 3-6*. National Science Teachers Association.

MSCCR Science Standard:
P.2.6.3 Develop a plan to change the force (push or pull) of friction to solve a human problem (e.g., improve the ride on a playground slide or make a toy car or truck go faster). Use an engineering design process to define the problem, design, construct, evaluate, and improve the plan.*

P.3.6.1 Compare and contrast the effects of different strengths and directions of forces on the motion of an object (e.g., gravity, polarity, attraction, repulsion, or strength).

P.3.6.2 Plan an experiment to investigate the relationship between a force applied to an object (e.g., friction, gravity) and resulting motion of the object.

P.5.6.1 Obtain and communicate information describing gravity's effect on an object.

P.5.6.2 Predict the future motion of various objects based on past observation and measurement of position, direction, and speed.

P.5.6.3 Develop and use models to explain how the amount or type of force, both contact and noncontact, affects the motion of an object.

Learning Objectives:
TSW identify gravity as the force that pulls objects down.
TSW compare and contrast the effects of different directions of forces on the motion of an object.
TSW model the effect of force on an object using a roller coaster.
TSW develop a plan to change the force applied to an object using a roller coaster.

Engage
"*Who has ridden or watched someone ride a roller coaster before? Show me your best Roller Coaster Face*! *Today, you are going to be roller coaster designers."*

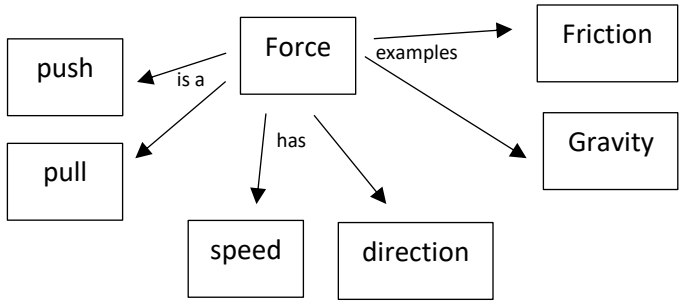
Explore
"*You have a homemade rollercoaster and a weighted ball. In your groups, see if you can make the ball roll from one end of the coaster to the other*." Allow time to try this. "*Now, you have a*

list of challenges to try using your roller coaster and ball. You may need to stand up to do these, so I will know you are done when you sit down and put the materials on your desk."

Classroom teacher will circulate to make sure students can successfully complete the challenges. Allow the students to have their own ideas as they work to observe, discuss, and draw conclusions, but offer guidance as needed.

Explain

- Give tips on how to complete each challenge if needed.
- How did you make the ball roll slower? (by raising one end a lot higher than the other)
- How did you make the ball roll faster? (by raising one end only a little higher than the other)
- How did you make a hill on your roller coaster? (by bending the middle up)
- How did you make the ball roll over two hills?
- How did you make the ball go through a loop on your roller coaster? (by making the beginning of the track steep and small loop close to the end)
- Did the ball ever fall off of the roller coaster? What made it fall?
- What causes the ball to go down the track? (Answers may vary; the next activity will introduce students to the concept of gravity.)



***Teacher note:** incorporate terms of acceleration, potential and kinetic energy, and momentum in the discussion as needed for your class.*

Elaborate

Let students retry one challenge after hearing the discussion of how forces work and tips on completing the challenges.

Evaluate

- Review what roller coaster engineers need to think about when designing roller coasters.
- Ask students to identify the force that pulls objects down. (gravity)
- Ask students to compare and contrast the effects of different directions of forces on the motion of an object.

Roller Coaster Challenges

1) Can you make the ball roll down the track and land in the cup?
2) Can you make the ball roll slower?
3) Can you make the ball roll faster?
4) Can the ball go over a hill?
5) What about two hills?
6) Can you make the ball go through a loop?