Unit 2 Force and Motion

Unit Summary: In this unit of study, students are able to determine the effects of balanced and unbalanced forces on the motion of an object.

Concepts and Vocabulary: Key vocabulary may include but are not limited to: Forces (e.g. number, size, direction, Balanced, Unbalanced), Motion (e.g. starting, stopping, or changing direction), Object, Cause and Effect, Patterns of motion (e.g. swinging pendulum, ball on curved track, magnet repulsion), Future motion

Stage 1 – Desired Results

Performance Expectations: (PE) (Established Goals / Content Standards)

3-PS2-1: **Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.** Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all. Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.

3-PS2-2: **Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.** Clarification Statement: Examples of motion with a predictable pattern could include a child swinging on a swing, a ball rolling back and forth in a bowl, and two children on a see-saw. Assessment Boundary: Assessment does not include technical terms such as period and frequency.

Enduring Understandings (1-3 max)	**Essential Questions** (1-2 EQ per EU)
Make predictions using patterns of change. Relationships exist between force and motion. Recognize cause and effect patterns.	What is the relationship between force and motion? How can we explain and predict interactions between objects? How can we predict an object's continued motion, change in motion, or stability? Why do objects move the way they do?

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations ● Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-PS2-1) ● Make observations and/or measurements to produce data to	**PS2.A: Forces and Motion** ● Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of	**Cause and Effect** ● Cause and effect relationships are routinely identified. (3-PS2-1) Patterns **Patterns** ● Patterns of change can be used to make predictions. (3-PS2-2) **Connections to Nature of Science Science Knowledge is**

serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (3-PS2-2)	motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (3-PS2-1) ● The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-2) **PS2.B: Types of Interactions** ● Objects in contact exert forces on each other. (3-PS2-1)	**Based on Empirical Evidence** ● Science findings are based on recognizing patterns. (3-PS2-2) Scientific Investigations Use a Variety of Methods ● Science investigations use a variety of methods, tools, and techniques. (3-PS2-1)

Stage 2 – Model Assessment	
Summative Performance Task **Bridge Engineering Activity** In this activity, students will create a bridge using a variety of materials such as books, paper, popsicle sticks, a ruler, scissors etc. Students can create a bridge that is meant to hold a certain amount of weight. Students will test how strong their bridge is by placing a stack of pennies on their bridge. Students will discuss what materials worked and why. Students will also discuss the concepts of force and whether their bridge withheld the weight of the pennies. **Self Assessment Rubric** https://www.exemplars.com/assets/files/seed.pdf	**Formative Evidence:** **Newsela Force and Motion Articles with Quiz** https://newsela.com/read/lib-nasa-forces-baseball/id/22498/ https://newsela.com/read/elem-how-roller-coasters-work/id/50891/ https://newsela.com/read/lib-nasa-four-forces-on-rocket/id/23123/ **Mystery Science Unit Assessments** https://mysteryscience.com/forces/forces-motion-magnets/assessments **Possible informal assessment to ask students to model with arrows forces in the following example:**

	-If two children stand with their hands together and push against each other, the pushing force each exerts balances to a net zero effect if neither child moves. Pushing a box from both sides also demonstrates a balanced force if the forces do not produce any change in motion or position of the box. **(Possible) Informal Assessment Discussion:** Investigating the effects of forces on objects will also give students opportunities to observe that patterns exist everywhere. Patterns are found in shapes, structures, natural environments, and recurring events. Scientists and engineers analyze patterns to make predictions, develop questions, and create solutions. As students have opportunities to observe forces interacting with objects, they will ask questions and analyze and interpret data in order to identify patterns of change in the motion of objects and to make predictions about an object's future motion. When students are on the playground, they can observe multiple patterns of change in the back-and-forth motion of a child swinging on a swing or in the up-and-down motion of a seesaw. In the classroom, students can observe a variety of objects, such as marbles rolling back and forth in bowls or tops spinning across the floor. **Pre/Post Assessment Possibilities** https://www.bvsd.org/curriculum/science/Force%20in%20Motion/Force%20in%20Motion%20Student%20Sheets.pdf

Stage 3 – Learning Plan and Resources
Suggested Resources for Planning: **Mystery Science:** www.mysteryscience.com **Newsela**: www.newsela.com

Robo Arm: This fun activity is one of five in a series of space based engineering challenges developed by NASA and Design Squad where students are engaged in implementing the Engineering Design process to build a robotic arm that can lift a cup off a table using cardboard strips, brass fasteners, paper clips, straw, string, tape and a cup. The activity includes an instructor's guide, questioning techniques, discussion questions, extension activity, a rubric, and 3 short video clips that enhance the purpose of the activity and its relevance to NASA.

Learning Activities:

Learning Activities (which can be found on Mystery Science), can include, but are not limited to:

Hopper Popper Activity
In this activity, each student will make and test a Hopper Popper.

Step 1: Print out materials and get supplies

Each student needs: ruler, pen, scissors, "light chipboard" to cut a 3" x 6" rectangle,Universal Science Recording sheet

For open-ended exploration, the class will also need: Extra chipboard for students who want to make additional hoppers. Rubber bands of different sizes and thicknesses.

Step 2: Prepare for class

If you want your students to practice measuring, you can have them cut 3" x 6" rectangles from chipboard before you begin this mystery. Otherwise, we recommend you cut the chipboard into 3" x 6" rectangles before class. It doesn't take long if you use a paper cutter.

Let's Investigate: Balanced and Unbalanced Forces
In this lesson, students will investigate how balanced and unbalanced forces affect the motion of a ball.
http://www.morethanaworksheet.com/wp-content/uploads/2015/06/Balanced-and-Unbalanced-ForcesInvestigation.pdf

Forces and Interactions Unit
The following lessons address the effects of balanced and unbalanced forces on the motion of an object.
http://www.mccracken.kyschools.us/Downloads/FORCES%20INTERACTIONS%203.pdf

The Great Slide Challenge
In this activity, students work in groups of 4 to test which materials have the most friction and which materials have the least friction. Each group makes a model of a slide using a stack of books and a piece of cardboard and turn their materials into "sliders".
https://mysteryscience.com/forces/mystery-3/balance-of-forces-friction/44?r=47229275

Free Internet Resources (includes: activities, videos, assessments)
https://thewonderofscience.com/3-forces-and-interactions
https://www.brainpop.com/science/energy/forces/

https://www.brainpop.com/science/motionsforcesandtime/newtonslawsofmotion/
https://www.cabarrus.k12.nc.us/cms/lib/NC01910456/Centricity/Domain/10075/ForceMotionTaskCardsDifferentiated.pdf

Suggested Methods: (The following methods anchor learning with a purpose, mitigating the “why do I need to know this” questions.)

- Phenomena based learning
- Problem Based Learning (PBL)
- Inquiry Based Learning
- Case studies
- Engaging in Argument w/ evidence

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