Unit 3.2: How can we design fun moving toys that other kids can build?
TABLE OF CONTENTS

Enduring Understanding: *Students will apply the following ideas to explain phenomena or design solutions to problems they experience in their environment:* Whenever we see an object starting to move, slowing down, stopping, or changing direction, we know a force has been applied. Objects in contact and objects at a distance can exert forces on each other. We can describe the relative directions of these forces (and strengths of contact and magnetic forces) and their effects on objects with different properties. Everyday objects like toy rockets and toy cars start to move, change direction, slow down or speed up as a result of an unbalanced (net) force applied to the object. When an object's motion does not change, such as when an object is at rest, the forces are balanced in all directions. We can use what we know about forces exerted by magnets, friction and electricity as criteria and constraints in designing how our toys move. We can design for and predict a pattern of motion for objects, including our toys.
Generalization(s): We can **predict the pattern of motion of objects**. **Unbalanced forces** cause a **change in motion**.

Overarching Phenomena (Unit Level): Homemade toys that move differently using different forces applied in different ways.

Final Artifact: Moving toys designed by students and design portfolios. Students will incorporate what they have figured out about forces that cause their toy to move in a description of the toy design problem and solution. Their portfolio will also include models showing forces acting on the toy and directions for building the toy. Students will identify artifacts from their science notebooks (e.g., models, data from investigations) to include in their design portfolios as examples of the engineering process that led to their design solution.

Primary PEs addressed in this unit

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.
K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
5-PS2-1 Support an argument that the gravitational force exerted by Earth on objects is directed 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.

3-PS2-3 Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

3-PS2-4 Define a simple design problem that can be solved by applying scientific ideas about magnets.

Secondary PEs addressed in this unit

3-5 ETS 1-1 Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.

Integration Planning

The Toy Unit's 4 Learning Sets include 19 Lessons representing the equivalent of 23 fifty-minute class sessions. Of the 19 lessons, guidance is provided to **integrate part or all of 9 lessons in class time devoted to literacy (7 lessons; ~**5 50-min class sessions**) or mathematics (2 lessons;** ~1.5 50-min class sessions). (See blue text for instructional minutes for each lesson.)

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Learning Set 1 - How can we make toys that move? (8 days)

Students observe, describe and analyze data, to make claims and develop models that describe the relationship between the parts of an object and the pattern of motion of the object including showing changes in speed and direction.

In Learning Set 1, students investigate the pattern of motion of different toys. They choose the type of toy they would like to design and follow instructions to build a prototype toy that they will revise throughout the unit as they learn more about force, motion and engineering design. In this learning set, students will investigate and develop models of the motion of their chosen toy.

L1.1 *What can we ask about the motion of our toys?* SEL (50 min)

Students observe a toy air rocket and brainstorm questions about how it moves. Groups of students explore different types of air rockets, generate questions about how rockets work and why each moves the way it does, share observations, and post questions on the DQB.

L1.2 *What do you and your family know about moving toys?* SEL/Equity (45 min)

Students are introduced to the driving question and share about their own and their families' experiences with moving toys. Students then observe and discuss how the motion of an air rocket changes during flight.

Add lit integration and ELA standards in Storyline

L1.3 *How can we predict the motion of our toys?* (45 min)

Students as a class develop, share, and revise models to represent the changes in motion of the air rocket during its flight.

L1.4 *How can we describe the motion of the toys we build?* (70 min)

Students view a video of a boy making his own toy. Groups of students build simple prototypes of a moving toy and record observations of patterns in motion as the toys moves.

L1.5 *How can we show our predictions about the motion of our toys?* (45 min)

Students develop and share models that show how their toy moves as a pattern.

L1.6 *How can other kids help us design moving toys?* (45 min)

Students interview younger students and define their design problem.

L1.7 *How did Lonnie Johnson design the Super Soaker?* (60 min)

(Portions or all of this 60-minute lesson could be integrated within the Literacy Block.)

Students engage in the Lonnie Johnson story *Woosh!* to obtain information about the engineering design process.

Learning Set 2 - What causes the motion of our toys to change? (5 days)

Students will use texts and fair tests to model the effect of unbalanced and balanced forces on the motion of objects (cause and effect).

In Learning Set 2, students are engaging in text about forces, planning a fair trial about forces, and then modeling balanced and unbalanced forces. Last, they apply these ideas to their designs.

L2.1 *What causes my toy to start moving?* (55 min - A portion of this lesson could be integrated within the Mathematics Block.)

Students investigate the rocket to model the forces that cause the rocket to start moving and forces that cause changes in motion.

L2.2 *Why doesn't the toy move?*

(55 min - A portion of this lesson could be integrated within the Literacy Block.)

Students engage in a text to support the design of a fair test of balloons traveling on a line.

L2.3 *How do surfaces made of different materials affect the motion of our toys?*

(45 min (+30 opt)) - All or a portion of this lesson could be integrated within the Mathematics Block.)

Students use mathematics to record and compare the different distances that cars travel across different distances.

L2.4 *How can I explain why my toy slowed down and stopped?* (45 min)

Students develop and share models of the balanced and unbalanced forces they observed in their toys.

L2.5 *What design solution will increase or decrease the frictional force on my toy?* (50 min)

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Students revise the design of the toy using the ideas of forces and how they affect motion.

Learning Set 3 - How can we design toys that will begin to move without being touched? (7 days)

Students engage in investigations, develop and revise models and solve design problems by applying scientific ideas about the effect of balanced and unbalanced forces (including gravity) on the pattern of motion of their toy.

In Learning Set 3, students are planning and conducting investigations, revising models, and constructing claims based on evidence that objects respond to non-contact forces.

L3.1 *How can we explain how our toy moved without us touching it?*
(50 min - A portion of this lesson could be integrated within the Literacy Block.)
Students develop models, obtain information from text and design solutions to problems related to gravitational forces.

L3.2 *What is causing these toys to change their motion?* (50 min - A portion of this lesson could be integrated within the Literacy Block.)
Students are planning and conducting an investigation of electrical forces and developing a claim that forces can be non-contact, based on the evidence they collected.

L3.3 *How can a magnet move a toy?* (50 min)
Students are planning and conducting an investigation of magnets and how they work to move objects. They are constructing a claim with evidence that magnets are noon contact forces, that depend on particular properties of the objects.

L3.4 *How can we change the magnetic forces used to move our toy?* (85 min)
Students are asking additional questions and then planning and conducting an investigation comparing the properties of objects and the relative change in motion. Students are developing claims based on the new evidence they collected.

L3.5 *How can I design my toy to start, stop, or change motion using magnetic or electrical forces?*
(85 min - A portion of this lesson could be integrated within the Literacy Block.)
Students are defining a solution based on the evidence from the learning set, and engaging in texts about non contact forces. They are sharing their plans with peers in order to get feedback and revise their solutions.

Learning Set 4 - How can we help kids build fun moving toys? (3 days)

Students will engage in argumentation with peers to revise the engineering solution and communicate information of balanced and unbalanced forces acting on their toy that cause it to start or stop moving or change direction.

In Learning Set 4, students are communicating their design solution to the younger audience after engaging in argumentation with their peers about the revisions to their design solutions.

L4.1 *How can I explain the design of my toy and how to make it?* (75 min - All or a potion of this lesson could be integrated within the Literacy Block.)
Students are redesigning their toys based on new evidence, presenting their solutions, and arguing that there is evidence that supports their design solution.

L4.2 *How can we share the details of our moving toy design with younger kids?* (45 min - All or a portion of this lesson could be integrated within the Literacy Block.))
Students are presenting their toys and their design portfolios to younger students. They are soliciting feedback from the younger students about whether the design solution worked as intended.

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