NVACSS Lesson Plan Template	
Grade Level: 3	**Topic: Motion and Matter - Force**
General Lesson Description: 3 - 50 minute Science Lessons & 2 - 70 Minute Math Lessons Students will focus on an engineering design cycle with a focus on designing a cart that will go the farthest and will cost the least. The lesson will be integrated during math instruction as well as science instruction and will be included during the teaching of the FOSS Motion and Matter kit. The lesson is not take the place of any FOSS lesson, it is intended as an extension of the FOSS module. The lesson should be taught after completing Investigation 3 Part 3 Investigating Start Position. Students will first draw the cart design they would like to use. Then with approval, they may begin to collect materials and build their cart. After completing the cart, they will use the price list and price out the individual cart pieces and find a total invoice price. Students will then test and redesign their cart and create a new invoice if needed. Students will create a table to determine which cart has the optimal design. Students will gather together and create a bar graph to determine which cart travelled the farthest distance. Students will write a reflection about the engineering design process, and how they worked as a group.	
Performance Expectation: 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. 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 in 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.**
Big Question: What is the best design for a cart that will travel the furthest distance for the least cost?	**Specific Learning Targeted Outcomes: 1. SW apply the engineering design cycle to Motion and Matter FOSS kit. 2. SW be able to identify the problem and design a cart that will provide an optimal design solution. 3. Possible solutions to a problem are limited by available materials (constraints) 4. SW understand that engineers look for the most cost effective solution to a design. (criteria) 5. Patterns can be observed and measured to predict future outcomes.**

NGSS Anchor Phenomena: **How can we use observed patterns of motion to design solutions to engineering problems? From - FOSS www.fossweb.com** **Show video clip of racecar** **https://www.shutterstock.com/video/clip-23499-night-drag-race-yellow-camaro-pro-mod**	
Background Information	
Prior Student knowledge to teach this lesson: Students should know that pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. Students have an understanding of gravity. Students will have an understanding of magnets and balanced and unbalanced forces. Students have an understanding of wheel and axle systems. Students will have already designed a cart and improved it.	
Teacher background information around big ideas: www.fossweb.com, https://educators.brainpop.com/bp-topic/cars/, https://www.weareteachers.com/nascar-teaching-ideas/, https://www.teachengineering.org/activities/view/cub_motion_activity1, https://ngss.nsta.org/Resource.aspx?ResourceID=374, http://www.scholastic.com/nascarspeed/	
Possible Student Misconceptions: Students may not realize that changing the wheels they use to create the cart can play a role in how far the cart will travel. Students may think that a good design only follows the criteria, and not take into account safety or stability in construction. Some students may think that more is better. Students may want to decorate or add embellishments to the cart that are not necessary to the task.	
Evidence Statements: How do students show mastery? ● **Students describe* the purpose of the investigation, which includes finding possible failure points or difficulties to identify aspects of a model or prototype that can be improved** ● **Students describe* the evidence to be collected, including:** 1. **How well the model/prototype performs against the given criteria and constraints.** 2. **Specific aspects of the prototype or model that do not meet one or more of the criteria or constraints (i.e., failure points or difficulties).** 3. **Aspects of the model/prototype that can be improved to better meet the criteria and constraints. b Students describe* how the evidence is relevant to the purpose of the investigation.** ● **Students create a plan for the investigation that describes* different tests for each aspect of the criteria and constraints. For each aspect, students describe*:** 1. **The specific criterion or constraint to be used.** 2. **What is to be changed in each trial (the independent variable).**	

3. The outcome (dependent variable) that will be measured to determine success.
4. What tools and methods are to be used for collecting data.
5. What is to be kept the same from trial to trial to ensure a fair test.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• Planning and Carrying out Investigations ○ Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.	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. PS2.A: Forces and Motion • 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.	• Patterns ○ Patterns of change can be used to make predictions. • Cause and Effect - Mechanism & Prediction ○ Routinely identified, tested, and used to explain change.

Lesson Plan: 5E Model

ENGAGE: Begin the lesson by showing the YouTube video clip about soap box derby cars. https://www.youtube.com/watch?v=Yayu_gKnj-I Read the book Michael's Racing Machine, by Lawrence F. Lowery. Introduce the engineering design challenge. (15 minutes)

Extension (Before you start): Students will be asked to bring in a toy car from home so that the students can see the different designs. Students will then sort the cars by their characteristics.

- Students will discuss the important features (characteristics) for a car and teacher will record ideas on an anchor chart. (20 minutes)

Assessment

Formative: Students brainstorm ideas to add to the anchor chart
Summative: N/A

Engage Materials Needed and Website/Other Resources:
https://www.youtube.com/watch?v=Yayu_gKnj-I
Book: MIchael's Racing Machine by Lawrence F. Lowery

EXPLORE:

1. **Teacher will define the criteria of the cart design based on previous investigations.**
2. **Teacher will present all of the materials available for purchase and the prices.**
3. **SW will be placed in teams of 2**
4. **SW will have 10 minutes as a team to decide on the materials and create an order for the items they want to use for the prototype the want to build.**
5. **SW have 10 minutes to draw a plan for the prototype and get teacher approval.**
6. **SW gather materials (criteria) needed and begin building. They will have 30 minutes (constraint) to build their cart.**
7. **SW draw a labeled diagram of their completed cart on the given worksheet.**
8. **SW complete an invoice of the total cost of the cart.**

Day 1 Math and Science Time

Assessment

Formative:

1. **Students draw a picture of their planned cart**
2. **Students fill in the order form for their parts**
3. **Students build their cart within 30 minutes**
4. **Students will draw a labeled diagram of their completed cart**
5. **Students will calculate the total cost of their cart**

Summative: N/A

Explore Materials Needed and Website/Other Resources: www.fossweb.com, FOSS Investigation Guide, craft sticks, binder clips, plastic disks large and small, green shafts, transparent tape, tongue depressors, zip bags, index cards, assorted wheels, assorted wooden dowels, straws, sticky price list, cart design worksheet

EXPLAIN: Have the students come back together as a whole group and ask, ¨What challenges did you face when designing your cart?¨ (different opinions, type of design, options, how to put it together, understanding wheel and axle system, making the wheels move/bearings) ¨What did you learn about designing your cart?¨(options are expensive, base price is where most of the cost is). "Did you see any patterns based on the distance that the cart travelled?" (range of distance, outliers, consistency of trials). ¨Were you surprised by the cost of each item that you used?¨ (Most will pick by the most colorful, which are more expensive, each item has a cost) Explain to student that when they purchase a car all of the extra things they buy are called ¨options¨ that add to the cost of the car. Ask, ¨When you add different options, will they improve the performance of the cart?¨

Day 2 - Math and Science

Explain Materials Needed and Website/Other Resources: Cart design worksheet, price list, completed carts

ELABORATE: Tell the students that they have now finished the design phase and will now start the testing phase. Each group will test the distance that their cart can travel. Two teams will work together to assemble a cardboard and clothespin ramp and tape it to the

floor. Teams will tape 2 measuring tapes end to end to the floor for a total distance of 200 cm from the base of the ramp. The procedure for the distance challenge is similar to the FOSS kit. Each team will then conduct a fair test of their cart and record the distance travelled on 5 runs on their recording sheet. Teams will line up the front wheels of their cart at a distance of 30cm from the base of the ramp. One student will release the cart without giving it a push and the other will measure and record the measurement of the where the front wheels are with the sticky notes. Students should start to recognize that there are patterns in the distance that the cart can travel. The range of cart distance per trial should be close to one another. Mention that if they have outliers, they should run another test to make sure they are accurate. Students should be able to make a cause and effect statement in their packet. Example: If I line up my cart at 30cm on the ramp, my cart will travel about _____cm. The total should be an average of their 5 trials. Students will then give their evidence in the next part. Students will have 15 minutes to modify or redesign their cart to make it travel farther or make it more sturdy or stable.This should be discussed as a change of variable. Mention that they should really try to limit the number of changes that they make. They should also be able to tell you if they plan on trying to make the cart travel farther or if they are trying to make a studier design. They will have to draw a new design or modify their existing design and complete a new invoice. Students will also return any materials that they no longer need. They will run the distance challenge and record the new data that they collected. Students will draw a labeled diagram of their completed cart and make sure they have completed the new invoice cost of their cart. Students will make a claim about the distance that their cart can travel.

Day 2 - Math and Science

Assessment

Formative:

1. **Students conduct a fair test and record the results of the distance that the cart travels**
2. **Students create a new order form to improve their cart design**
3. **Students calculate the new price of the cart**
4. **Students retest and record the distance that the cart travels**
5. **Students draw a labeled diagram of their final cart design**

Summative: Students make a claim about the distance their cart can travel

Elaborate Materials Needed and Website/Other Resources: www.fossweb.com, FOSS Distance Challenge lesson,ramps, clothespins, masking tape, meter tape (2 - taped to the base of the ramp and then taped together to have a total distance of 2 meters/200cm) 30cm measurement construction paper sheet to attach to the ramp, recording sheet, 2 different colors of sticky notes to record distance on the meter tape.

EVALUATE: **Students will come together Whole Group to discuss their results and share their claims and evidence. Each group will share their cart design and their results of their distance challenge. Teacher will conduct a last run to determine if students' measurements were close to accurate. Students will then record each team´s data on**

their Cost/Distance table. After all of the carts have been tested, students will return to their seats to create a bar graph of the results to determine the optimal cart design. Label the carts (X-Axis) based on how many carts have been created. Label the Y-Axis Distance Travelled (cm). Create a scale (Y-Axis) to be used by everyone. Students can then complete the bar graph using colored pencils or crayons. Based on this information, students will decide which design they feel is optimal. Student´s will then write a reflection on the engineering design process and what they learned about designing a cart. **Day 3 Science**
Assessment **Formative:** 1. **Create a bar graph of the distance that each cart travelled** 2. **Students record cost and distance travelled in a table and then determine which design is optimal** **Summative:** 1. **Reflection of the engineering design process** 2. **FOSS Investigation 3 I-Check**
Evaluate Materials Needed and Website/Other Resources: Bar graph worksheet, cost/distance worksheet, reflection
Comments/Teacher Tips: This was a great activity and the students really enjoyed creating the carts. They found the lesson very challenging. As an extension to FOSS this activity students are required to make accurate measurements of the distance their cart travelled, as well as add up multiple numbers for the parts they want to purchase. Watch students as they are conducting the distance challenge to make sure they are not pushing the carts. This will lead to inaccurate results.They also complete a bar graph of collected data. Make the students accountable at each step. Encourage students to make small changes during the redesign phase, discourage a complete redesign or rebuild.