LESSON EXTENSION: LAWS OF MOTION, ENGINEERING DESIGN PROCESS

Lesson Plan 1
Summary of Key Learning Interactions and Instruction

Lesson 1: Motion & Force

Learning Objectives:

1. Students will recognize examples of motion and force in the physical world.
2. Students will demonstrate that an object in motion will stay in motion or an object at rest will stay at rest unless acted upon by an outside force. (Newton's First Law)
3. Students will determine that acceleration is produced when a force acts on a mass. The greater the mass, the greater the amount of force necessary to accelerate the mass. (Newton's Second Law)
4. Students will conclude every action is followed by a reaction equal in magnitude and opposite direction. (Newton's Third Law)

Formative Assessment:

1. Exit ticket - students will answer an exit ticket question by the end of the lesson.
2. Observation

Summative Assessment:

3. Students will answer questions showing their understanding of the three laws of motion.

Interactions/Activities	Differentiation	Materials/Resources	Field Experiences/Adult Relationships
Description: Examining Newton's first law of motion. Use the following link for student's to watch as you move through the first law of motion https://www.youtube.com/watch?v=gwukMqwBB_s **Steps:** Show the students the activity log page with the definitions and explanations of Newton's Laws of Motion. Direct the students to the front for the video about the first law of motion and show the laws of motion video, pausing at 1:21 to discuss with students Newton's First Law of Motion. https://www.youtube.com/watch?v=gwukMqwBB_s Re-introduce the term "inertia" which is another word used to describe the first law of motion. Conduct a Think-Pair-Share session and have students discuss their ideas of an	**Intervention:** Have students take out Newton's Apple or any random objects from their surroundings so they can experience the first law during the demo. (Connections to Experience) **Extension:** Have students create an example that illustrates Newton's first law using the object around the classroom, or from items they brought to class (Connections to Experience, Discipline) **Intervention:** Students will work in pairs or groups in creating examples that illustrate Newton's first law. (Connections to	▪ Activity worksheet ▪ Objects that can roll, with different masses (i.e, tennis ball and kickball, paperclip, etc.)	▪ Stepping outside the classroom and identifying motion and force in the physical world.

object at rest. Have students think about unbalanced forces, or forces that would cause the object to stop being at rest. Students may share their responses. Have students think about objects in motion and unbalanced forces that may stop the object from moving in a straight line. Demonstrate a rubber ball (or any rolling object) rolling across the room, and asking what stops the item, or what can potentially accelerate, or speed up/change direction, off its course of moving in a straight line.	Experience, Discipline, Integrated Communication)		
Description: Examining Newton's second law of motion. **Steps:** Demonstrate the second law of motion to students. Explain that the weight of an object is the force that gravity exerts on it and the standard metric unit of force is called the Newton. Explain that force is the product of mass multiplied by acceleration, meaning, the greater the mass of an object, the greater the force needed to accelerate the object. Show students the video https://www.youtube.com/watch?v=EJkPF21tORE stop at 1:56. Ask students to think about the tennis ball and kick ball, comparing the masses and deciding which object has more mass. Have students volunteer to demonstrate the force needed to toss either ball to each other; students should observe the force needed to toss the ball with more mass compared to the ball with less mass.	**Intervention:** Have students take out any random objects from their box and pass around so they can experience the second law during the demo. (Connections to Experience) **Extension:** Have students create an example that illustrates Newton's second law using the objects from their box. (Connections to Experience, Discipline) **Intervention:** Students will work in pairs or groups in creating examples that illustrate Newton's second law. (Connections to Experience, Discipline, Integrated Communication)	▪ Objects of different masses to demonstrate the laws of motion	▪ Stepping outside the classroom and identifying motion and force in the physical world.
Description: Examining Newton's third law of motion. **Steps:** Demonstrate the third law of motion to students. Ask students if they can identify an action-reaction pair that is created	**Intervention:** Have students take out any random objects from their box and pass around so they can experience the third law during the	▪ Balloon ▪ Fishing line or string ▪ Tape ▪ Scissors ▪ Straws ▪ Targets	▪ Stepping outside the classroom and identifying motion and force in the

when holding an object, like a rubber ball. Demonstrate to students that the action experience between the two objects (the ball and the ground) is experienced when the two meet, and the reaction is when the ball bounces up. Emphasize to students that the ball will bounce higher depending on the amount of force, and lower to the ground when less force is applied. Show video https://www.youtube.com/watch?v=gQZS1vGu_TQ for Newton's Third Law of Motion Ask students if they have ever blown a balloon up and released it, and what happens with that balloon. Discuss with students that the action occurring is the air exiting the balloon, and the reaction is the balloon moving in the opposite direction of where the air comes out. **Optional activity:** Balloon Rocket ● Set up a fishing line or string about 10 or more ft., you may set up several stations based on your class size ● Cut plastic straws in 2" length and secure the string through one piece. ● Use a balloon pump to fill balloons with air ● Using a piece of tape, attach a part of the balloon to the straw secured on the fishing line and bring it the a starting point ● Use clothes pins to keep air inside as students set up ● To make activity more exciting, place character images midway or at the end of the string for students to target when their balloon is released ● Students may measure the distance their balloon travels; targets may have set distances for easier measurement ● Pumps may be set per balloon and can be used to graph at the	demo. (Connections to Experience) **Extension:** Have students create an example that illustrates Newton's third law using the objects from their box. (Connections to Experience, Discipline) **Intervention:** Students will work in pairs or groups in creating examples that illustrate Newton's third law. (Connections to Experience, Discipline, Integrated Communication)	▪ Clothes pins	physical world.

end of the lesson for distance traveled relative to how many pumps are needed to fill the balloon. Three trials can be conducted, with the amount of air pumped into balloons increasing. • *Have students make predictions based on how many pumps of air the balloon is filled with and the distance it will travel*			

Lesson Plan 2
Summary of Key Learning Interactions and Instruction

Lesson 2: Engineering Design Process

Learning Objectives:

1. Students will recognize the engineering design process is a method of problem-solving used to create a system, a product, or a process that meets an identified need.
2. Students will apply the steps of the Engineering Design Process to solve a simulated or real-world problem.

Formative Assessment:

1. Exit Ticket – students will answer exit ticket questions by the end of the lesson.
2. Observation

Summative Assessment:

1. Students will apply the engineering design process in performing the bridge quest task.

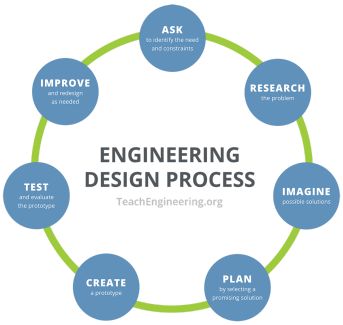
Culminating Assessment:

1. Students will design the safety restraint device Eggsy's glider.

Performance Assessment:

1. Students will present their completed project and test their design.

Interactions/Activities	Differentiation	Materials/Resources	Field Experiences/Adult Relationships
Description: Students will apply the engineering design process in a real-world situation. ***SCENARIO***: Eggbert's cousin, Eggsy is a thrill-seeker who loves the outdoors. Eggsy has tasked students from your school to build a safety restraint device that will protect him from jumping from high heights. **Steps:**	**Intervention:** Use of Engineering Design Process wheel. (Connections to Discipline) **Extension:** Redesign the bridge to withstand an increased drop height. (Connections to Experience) **Intervention:** Students will work in groups to	▪ Engineering Design Wheel	▪ Authentic task that allows students to connect what they learned in a real-world scenario.

Students will perform and complete a task using the engineering design process to test and evaluate a prototype in order to protect an egg from cracking from designated heights; if your school has a second floor, even better!  Move through the engineering design process with your students and discuss what they will be doing within each process. Find the attached checklist at the end of this lesson. 	complete the task. (Integrated Communication)		
Description: Students will research different types of restraining devices. **Steps:** Students will conduct research on restraint devices that they can use on their design for Eggsy; forces such as elasticity, friction, gravity, and newton's third law action reaction can be considered	**Intervention:** Use of Engineering Design Process wheel. (Connections to Discipline) **Extension:** Extend their research online. (Connections to Discipline) **Intervention:** Students will work in groups to complete the task. (Integrated Communication)	▪ Laptop/tablet ▪ Activity log ▪ Raw Eggs (varies with class size, 2-4 per group) ▪ Makerspace	▪ Authentic task that allows students to connect what they learned in a real-world scenario.

LESSON EXTENSION: LAWS OF MOTION, ENGINEERING DESIGN PROCESS

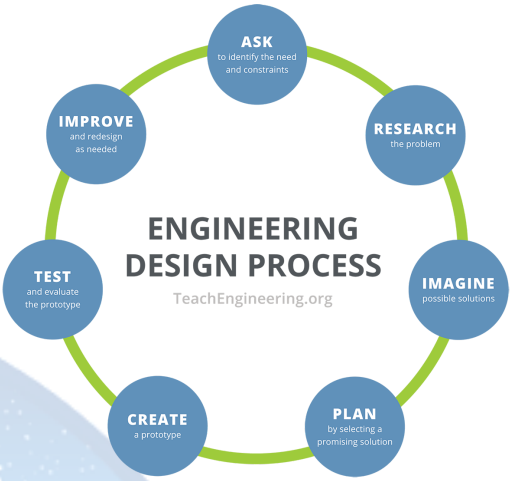
Description: Students will design a protective casing for Eggsy **Steps:** Students will design their protective cases based on their research given the criteria and height designated by the teacher. Ensure that the height drop variable is consistent throughout each group's project for data. Show students the materials they will be working with. Students will design their prototype individually and be allotted a set amount of time to pitch their ideas to their teammates (see worksheet below). This will allow students who may feel less creative an opportunity to demonstrate their abilities. Give students 3-5 minutes to design and write their materials down. Give each student 2-3 minutes to share their design, choosing the design they think will work best. Emphase that students may have similar ideas and this is a great way to use collaboration and bring ideas together and create a potentially more efficient prototype. Once students decide on their design, allow them to use makerspace to begin building their designs. **If time and supplies permit, have students redesign their prototype and conduct further trial(s)** **MATH OPPORTUNITY:** ● Mass students' prototypes with digital scale ● Bar/Line graph to measure drop height and success/fail rates ● Assign values to items and provide students with a budget ● Have students identify the monetary denominations they need for payments **SCIENCE CONNECTION:** Laws of Motion	**Intervention:** Use of Engineering Design Process wheel. (Connections to Discipline) **Extension:** Conduct three trials, change heights in which the egg is dropped **Intervention:** Students will work in groups to complete the task. (Integrated Communication)	▪ Activity log/worksheet ▪ Glider ▪ Eggsy box containing materials for designing a restraint device.	▪ An engineer community partner will evaluate students' final product.

1st Law - Object in Motion; Unbalanced force *2nd Law* - F=ma *3rd Law* - Action Reaction **TECHNOLOGY CONNECTION:** Research Use of technological tools			

Engineering Design Process Checklist

MY TEAM COMPLETED THE FOLLOWING STEPS OF THE ENGINEERING DESIGN PROCESS:

- ☐ **Ask**
- ☐ **Research**
- ☐ **Imagine**
- ☐ **Plan**
- ☐ **Create**
- ☐ **Test**
- ☐ **Improve**



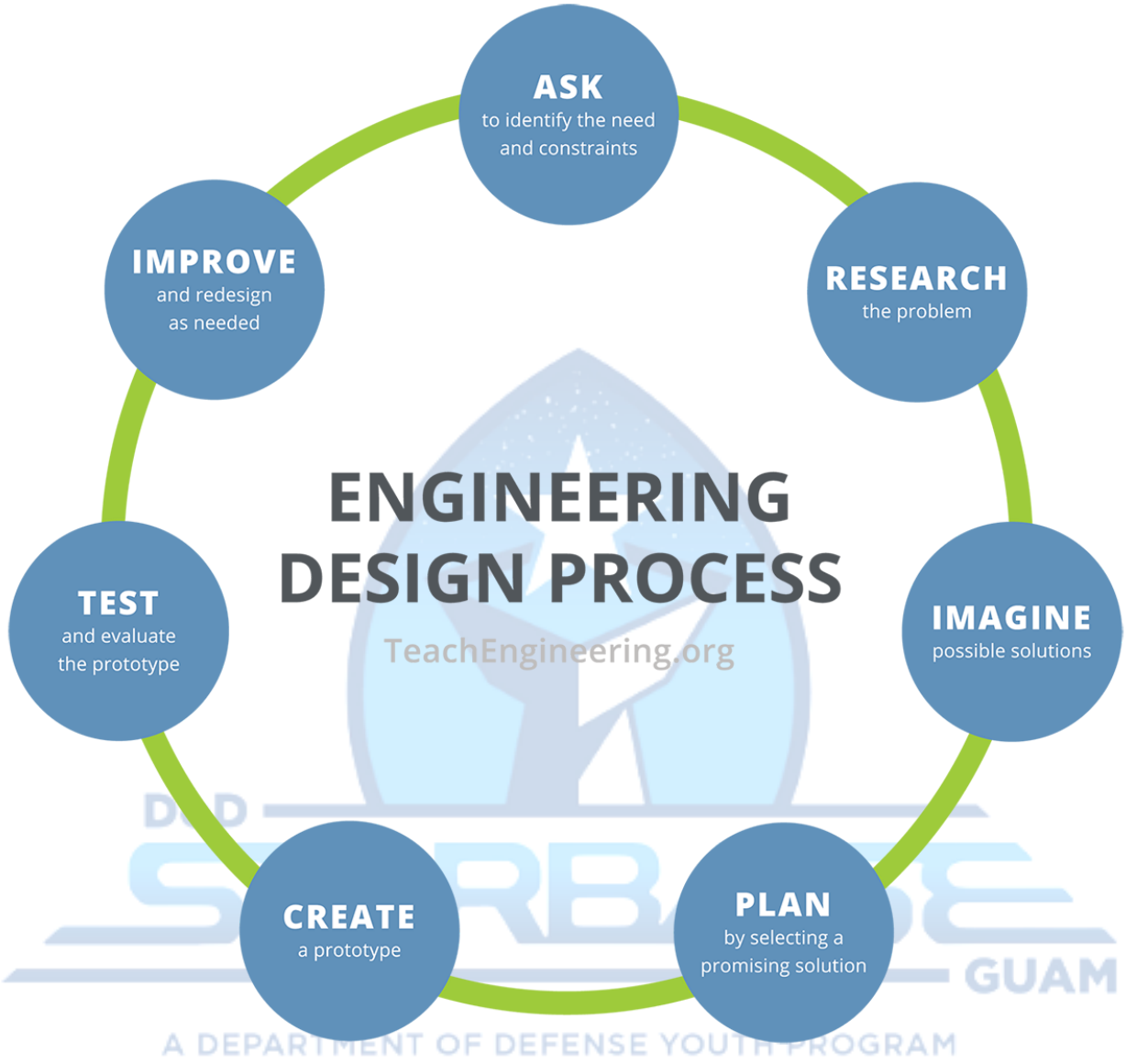
USE THE FOLLOWING SPACE TO DESIGN YOUR PROTOTYPE. LIST THE MATERIALS YOU USED AT THE BOTTOM OF THE PAGE. SHARE YOUR IDEAS WITH YOUR CLASSMATES TO DEMONSTRATE POSITIVE COMMUNICATION AND COLLABORATION

Materials Used:

Performance/Student Choice Assessment

Objectives	Rubric Scale				
	4	3	2	1	0
The learner will solve problems using ratios expressed as a fraction, a decimal, or a percent.	Students can convert fractions to decimals and vice versa and convert fractions and decimals to percent and vice versa. Students can apply and solve problems using ratios expressed as a fraction, a decimal, and a percent with no help.	Students can convert fractions to decimals and vice versa and convert fractions and decimals to percent and vice versa. Students can apply and solve problems using ratios expressed as a fraction, a decimal, and a percent with little to no help.	Students can convert fractions to decimals and vice versa and convert fractions and decimals to percent and vice versa with no help.	Students can convert fractions to decimals and vice versa and convert fractions and decimals to percent and vice versa with help.	Students need a lot of help in solving and converting fractions to decimals and vice versa and converting fractions and decimals to percent and vice versa.
The learner will recognize the engineering design process is a method of problem solving used to create a system, a product, or a process that meets an identified need.	Students collaborate and communicate with his team in designing their safety restraint device and keep a log of their process, progress, materials, and budget. Student is sharing his/her ideas and thoughts with his/her team and listens to individual input on their project. Student actively creates the	Student communicates with his team in designing their safety restraint device and keeps a log of their progress, materials, and budget. Student is sharing his/her ideas and thoughts with his/her team. Student actively	Student communicates with his team in designing their safety restraint device and keeps a log of their materials. Student is sharing his/her ideas and thoughts to his/her team. Students create some parts of the safety	Student communicates with his team in designing their safety restraint device. Student is sharing his/her ideas and thoughts with his/her team, with some participation in creating a safety restraint device.	Students communicate with his team in designing their safety restraint device with little to no participation in creating safety restraint devices.

	safety restraint device with the team.	creates the safety restraint device with the team.	restraint device.		
The learner will apply the steps of the Engineering Design Process to solve a simulated or real-world problem.	Students can apply the eight steps in the Engineering Design process to completing their project.	Students can apply the 6-7 steps in the Engineering Design process to complete their project.	Students can apply the 4-5 steps in the Engineering Design process to complete their project.	Students can apply the 1-3 steps in the Engineering Design process to complete their project.	Students can apply 0 steps in the Engineering Design process to complete their project.
The learner will recognize examples of motion and force in the physical world (Newton's Law of Motion.	Students will recognize the motion and force acts on Eggsy and the glider in the crash simulation without help from the teacher.	Students will recognize the motion and force acts on Eggsy and the glider in the crash simulation with little to no help from the teacher.	Students will recognize the motion and force acts on Eggsy and the glider in the crash simulation with medium help from the teacher.	Students will recognize the motion and force acts on Eggsy and the glider in the crash simulation with help from the teacher.	Students will recognize the motion and force acts on Eggsy and the glider in the crash simulation with help and guidance from the teacher.
Total Possible Points:	**16 Points**				



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