Name: _____ Date: _____

Elementary Engineering Design Process - Build a Bumper Car

Goal:

- Lesson 1: Your task is to create a diagram of a bumper car that is safe in a collision.
- Lesson 2-6: Your task is to create and refine a prototype of a bumper car.

Role:

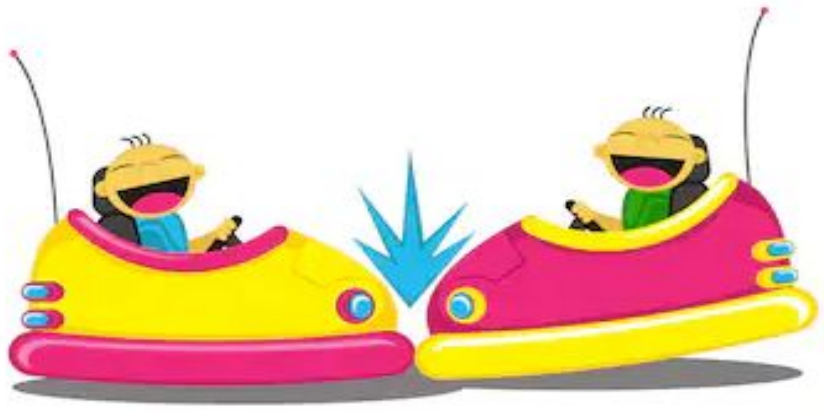
- You are an engineer with the Acme Car Manufacturing Company

Product/Performance and Purpose:

- By the end of unit 3, you will need to modify a rubber band car to a bumper car that is safe during a collision.

Standards and Criteria for Success:
Criteria: This can be a dream bumper car, but should include some elements that students predict will make it safer.

Constraints: You may only use the materials provided for you: rubber bands, cardboard, straws, CDs or DVDs, Masking or other heavy tape, scissors, Optional: Milk or juice cartons



Student Rubric
Engineering Design

Part 1 (Lesson 1):

Lesson Overview
Students will design a rubber band car using a defined set of criteria and constraints. They will build a prototype to help them explore how cars **move** and what happens when they collide.

Essential Question: What happens when objects collide?

Lesson Objective
SWBAT design a rubber band car that moves.

Use this space to draw/design your bumper car. Make sure you label each part indicating which materials you used.

	Materials: - Rubber bands - Cardboard - Straws - CDs or DVDs - Masking or other heavy tape - Scissors

The rationale for the design (why did you pick this design)?

_____

_____

_____

_____

Part 2 (Lesson 2)

Lesson Overview
Students will design a rubber band car using a defined set of criteria and constraints. They will build a prototype to help them explore how cars **move** and what happens when they collide.

Essential Question: What happens when objects collide?

Lesson Objective
SWBAT create a rubber band car that moves.

Students will build their rubber band car with the materials below.

Materials: - Rubber bands - Cardboard - Straws - CDs or DVDs - Masking or other heavy tape - Scissors	**Criteria:** This car should include some elements that students predict will make it safer. The car must be able to move. Say: Remember a collision occurs when two or more objects run into each other. What elements could make your car safer in a collision? **Constraints:** You may only use the materials provided for you.

What materials did you not use and why?

What design elements did you include that will help keep passengers safe? Explain why.

Part 3 (Lesson 3)

Lesson Overview
Students will use the cars that they built in lesson 2 to test the impact that energy has on speed.

Essential Question: What happens when objects collide?

Lesson Objective
SWBAT: conduct an investigation with rubber band cars in order to show the connection between speed and energy.

Today, we will make inferences on how different variables change the amount of energy a car has. Students will conduct investigation with rubber band cars.

- You must conduct 3 trials, pulling the rubber band back at different intervals each time (8,12,and 16 cm).
- You must measure the distance that you pull the rubber band.
- Record how far your car went on the chart below.

Trial	Measurement of how far the car went
Trial 1 (8 cm)	
Trial 2 (12 cm)	
Trial 3 (16 cm)	

Answer the following question when the trials are completed.

How did the car's speed change based on the different distances?

Part 4 (Lesson 4)

Lesson Overview
Students will explore energy how is changed/transferred during a collision by observing and diagraming a domino chain. In lesson 5 and 6, students will apply these observations to make claims about how energy is being transferred in a bumper car collision.

Essential Question: How is energy transferred when objects collide?

Lesson Objective
SWBAT creates a diagram mapping the transfer of energy in a domino chain.

Watch one of the following videos:

- https://www.youtube.com/watch?v=lo6x4eulY9g&disable_polymer=true
- https://www.youtube.com/watch?v=0lz8_aaKNXA&disable_polymer=true

Answer the following question:

- Where did you see energy in this video? How do you know?

_____

_____

_____

- Where did the observed energy come from?

_____

_____

_____

Draw your domino chain.

Test the following questions:

- Do you think the dominos movement would change if I pushed more firmly or gently?
- Using what you have learned and observed about energy, can you think of a way to knock the dominoes down without touching it?

After testing using your dominos, answer the questions above.

- Do you think the dominos movement would change if I pushed more firmly or gently?

_____

_____

_____

_____

_____

- Using what you have learned and observed about energy, can you think of a way to knock the dominoes down without touching it?

_____

_____

_____

_____

_____

Part 5 (Lesson 5)

Lesson Overview
Students will build upon their knowledge from lesson 3 and 4 to understand how affects the energy transferred during a collision. Students will “crash test” their rubber band cars from lesson 2 and make observations about how increased speed/energy affects objects in a collision. Students will observe that the more energy the car has, the more energy must be transferred upon collision. In lesson 6, students will use these observations in conjunction with their learning from lesson 4 to guide their bumper car designs.

Essential Question: How is energy transferred when objects collide?

Lesson Objective
SWBAT Test and evaluate the safety of a car during collisions at different speeds.

Students will use the attached (blue paper) chart to record how safe the cars are at different speeds.

After testing, answer the following questions:

1.) How did energy affect your car in the collision? Use evidence from your observation to support your claim.

_____

_____

_____

_____

_____

2.) How safe do you think your car would be in a real collision? Why or why not?

_____

_____

_____

_____

_____

3.) How safe do you think your passenger would be in a real collision? Why or Why not?

_____

_____

_____

_____

_____

Part 6 (Lesson 6):

Lesson Overview:
Students will apply knowledge gleaned from previous lessons in this unit to work with a team of engineers to design, test, and iterate the "world's fastest bumper" so that is is functional, fun, and safe in a high energy collision. Students will prove their claim by using comparing their unmodified rubber band car (lesson 2) to their group's new design and gathering evidence that their new iteration mitigates the effects of a high energy impact collision.

Essential Question: How is energy transferred when objects collide?

Lesson Objective
SWBAT design and build a bumper car prototype that mitigates the effects of energy transferred in a collision.

Your Goal: Modify a rubber band car to make a bumper car that is safe and comfortable during a high energy collision.

Consider the Following: How do I know if my group's model is successful?

- Upon impact, a successful bumper car model will lessen the effects of potentially problematic energy transfer including:
    1. Passenger movement
    2. Damage to bumper car
    3. Displacement of bumper car
    4. Noise

Plan: *Using your original design, draw a modified bumper car to help increase safety of your passanger.*

Modified Bumper Car Design

Were other designs discussed? Why were they not chosen?

How did the constraint of the materials impact the design?